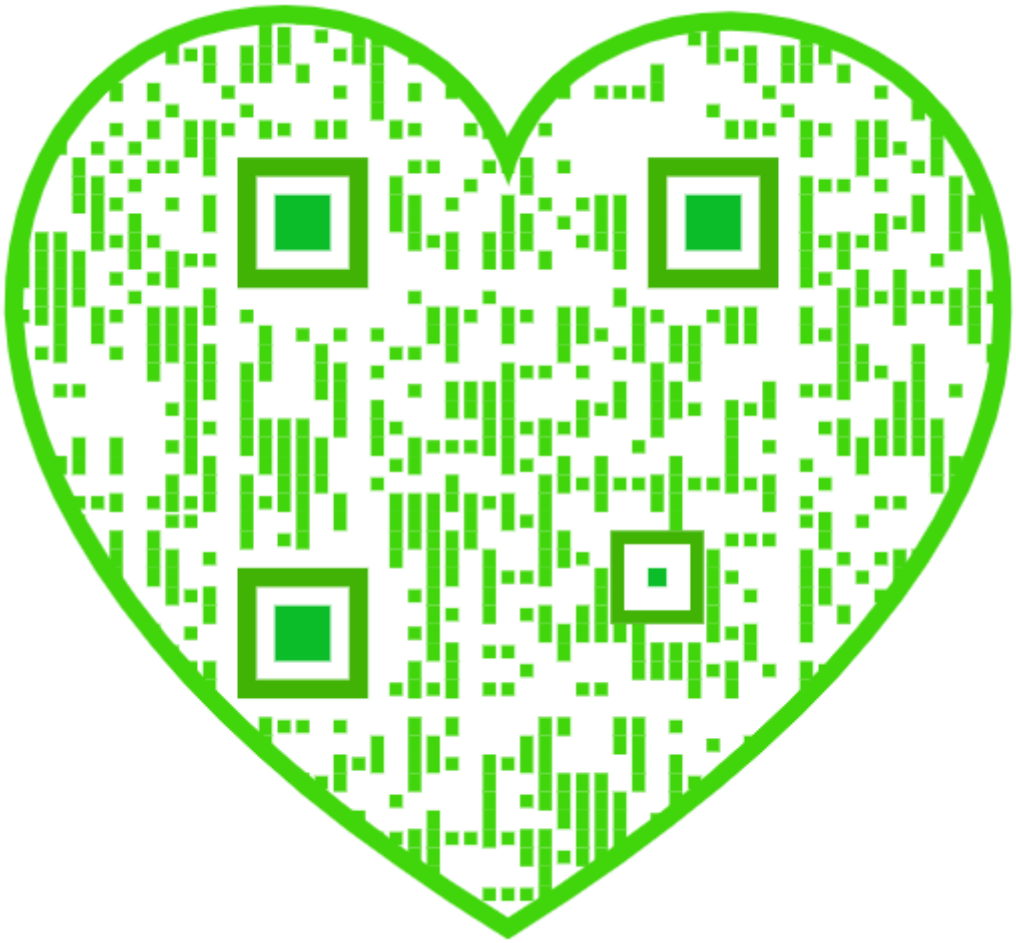

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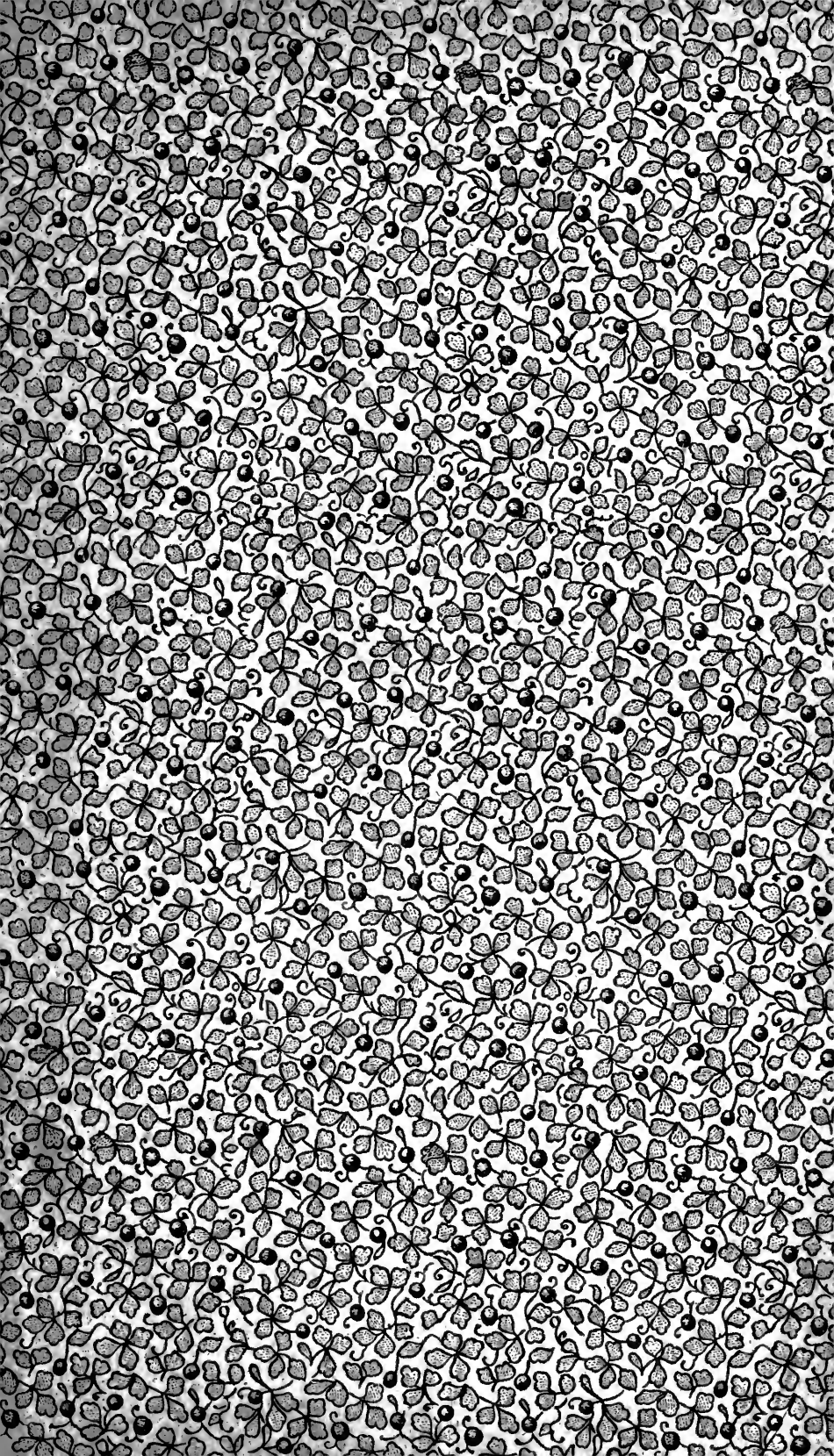

A Rape Plant Grown for Seed.

— Whatcom County, Washington.

FORAGE CROPS

OTHER THAN GRASSES

How to Cultivate,
Harvest
and Use Them

By...
THOMAS SHAW

Professor of Animal Husbandry at the University of Minnesota

Author of
"Public School Agriculture" "Weeds and How to Eradicate Them"
"The Study of Breeds" "Soiling Crops and the Silo"

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To the Farmers and Stockmen of America, this work is most respectfully dedicated by the Author.

AUTHOR'S PREFACE

This work has been written in the hope of meeting a long-felt want. It has been the aim of the writer to adapt it to the needs of the farmer, the stockman and the agricultural student. It is left with the agriculturists of this country to say how far these objects have been attained.

University Experiment Farm,
St. Anthony Park, Minn., 1900.

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CHAPTER I.

FORAGE CROPS.

Forage in its widest sense means any food suitable for horses, cattle, sheep and swine. Thus applied, it would include pasture, soiling and fodder crops, and all manner of matured seeds. In the title given to this book, however, and in the book itself, it will be used only in the more restricted sense of pasture crops other than those provided by the various grasses. It is thus used for the reason, first, that in the ordinary phraseology of the farm, it is so understood. Second, that there is a felt necessity for a more restricted and precise use of certain terms in agriculture that have heretofore been used in a loose sense. And, third, that it would seem to express the various subjects considered in the book more accurately and more concisely than any other term that could be chosen. The terms forage crops as thus defined, and pastures, are frequently regarded as synonymous and interchangeable. But grasses are not included in the discussion, for the reason, first, that where grazed off they are usually spoken of as pasture crops, and, second, that to include them would unduly swell the contents of this volume.

In nearly all instances these forage crops are sown from year to year, whereas grass pastures usually endure for several years. In many instances the latter grow, as it were, spontaneously; the former seldom do. Forage crops, like pastures, are fed off

by the animals where they grow, and usually in the green form; but there are instances where both may be grazed in the matured form, as in the gleaning of ripe peas by swine, or the grazing of buffalo or bunch grass by cattle and sheep in the winter. Some of these forage crops are grown and grazed off in succession the same season, and are also sown as "catch" crops, while grasses are never thus sown or grazed. And some forage crops, as, for instance, Jerusalem artichokes, are gathered from beneath the surface of the ground, whereas grass pastures are grazed only on the surface.

Soiling and Fodder Crops not Considered.— In this book the question of forage crops only will be considered, although excellent reasons may be given for including soiling and fodder crops in the discussion. Soiling food may be defined as food cut or pulled and fed to animals in the green form. And fodder crops may be defined as food for live stock in the matured form, and fed before or after the removal of the seeds. Both definitions are restricted rather than general, as both terms are sometimes used, and, perhaps unfortunately, in a wider and more general sense. Among the reasons that may be given for including these crops in the discussion, are the following: First, forage, soiling and fodder crops each includes a large number of the same plants. And, second, the processes of preparing the land for many of these and of growing them up to a certain stage are exactly the same. Discussing these various classes of crops therefore together would avoid no little repetition, which it would be impossible to avoid when discussing them separately. But to this plan there is

the one strong objection, *viz.*, that it would so swell the contents of the book as to make it too unwieldy for commercial use as a text-book. It would also increase unduly the cost of the book to those readers who are desirous of obtaining information only with reference to one phase of this three-fold question.

Possible Exception to Definitions.—Agricultural literature is only in what may be termed the formative stage. And more especially is this true of agricultural text-books. Exception may be taken, therefore, by those critically inclined to almost any definition that may be given of forage crops, and, indeed, of other classes of crops, as, for instance, cereals and field roots. In formulating definitions in agriculture, no better plan, perhaps, can be followed than to give heed to the common understanding regarding the meaning and application of the various terms in use. But this common understanding is not an absolutely safe guide, since it differs sometimes in communities in regard to the use of a certain term, and often it differs even in the same community. Some time must elapse, therefore, before definitions in agriculture will so crystallize as to assume a form so definite and abiding that it will meet with universal acceptance.

A Greatly Important Question.—The growing of forage crops is to-day what may be termed a burning question, and it is likely to become more and more so with the passing of the years. Some time, and in the future that is near, forage crops other than grasses will be grown from sea to sea, but, of course, not equally in all parts of the continent. The exceptions will be the range and mountain districts, which forbid a varied agriculture.

But little attention has been given to the growing of this class of forage crops in the past, and for manifest reasons. The history of our agriculture has been largely one of occupancy. Men have taken possession of the soil and tilled it after the most primitive fashion. Such, at least, has been its history in all the west. While it is true that some progress has been made in intensive cultivation in the east, such farming has been greatly hampered by the tide of agricultural products which has flowed eastward in great volume from the cheap and fertile lands of the Mississippi basin. On every hand, however, there are indications of change. The unoccupied tillable domain is only a fraction of what it was. And this means that the great grazing lands of the tillable prairies are only a fraction of what they once were. There is no further west. Populations are increasing at a very rapid rate, and, therefore, a more intensive cultivation will soon become a necessity in all parts of the continent. And with the increase of intensive cultivation, as surely as the sun goes down in the evening, increased attention will be given to the growing of these forage crops, some of the reasons for which will be stated below.

Why Forage Crops Should be Grown.—Forage crops, other than grasses and clovers, should be grown because of the many benefits which they bring to those who grow them. Chief among these are the following: First, they may be made to supplement pasture crops that are more permanent, that is to say, perennial in character, when the area of these is insufficient, or when from any cause or causes they may fail to produce plentifully. Second, many of them may be grown as catch crops where other crops have failed

to grow, hence the use of the land for the season is not lost. Third, by growing these crops the farmer is enabled proportionately to increase the live stock of his farm, and, in consequence, proportionately to increase its producing power. Fourth, such a system exercises a salutary influence on weed eradication, because of the frequency with which the ground is plowed and otherwise disturbed, and because the weeds which grow in the forage are usually eaten down before they mature their seeds. Fifth, it enables the farmer to provide succulent pasture for animals at certain seasons of the year, when ordinarily it could not be obtained in any other way. And, sixth, it provides vegetation that may be plowed under with great benefit to the land, when, because of its abundance, it has been only partially consumed while being grazed.

Who Should Grow Forage Crops.—All farmers on small or moderately sized holdings who keep live stock should also grow forage crops in addition to their grass pastures, since they so much reduce the area required for the latter. But those stock growers who live on large holdings, and more especially those of them whose tillable lands are in climates where the rainfall is oftentimes less than could be desired, should also grow them. In these areas the yields from grass pastures are frequently small, very much less than can be obtained from crops sown expressly to provide pasture for a single season or but a part of a season. As a rule, therefore, the necessity for growing these crops will increase with the less favorable conditions for growing grass pastures, and vice versa. Those crops can, however, be more profitably grown to furnish grazing for sheep and

swine than to furnish the same for cattle and horses, since the tramping of the latter, while grazing, leads to a greater percentage of waste in the pasture. Nevertheless, some of these pasture crops may be grown with great advantage by dairymen, more especially in the prairie country west of the Mississippi.

The Possible Outcome.—When farmers generally who live upon arable lands give that attention to the growing of this class of forage crops which they ought to, from the standpoint of self-interest, no limit can be set to the possible increase in live stock and live stock products. More especially will this be true when they give that attention also to the growing of soiling and fodder crops which their importance demands. In those encouraging days that are drawing near, the production in these lines that will be obtained from small areas would astonish many of the farmers of to-day. And the increase will no less apply to the quantity than to the quality of the product, because of the suitable character of the food furnished, because of its seasonableness and because of its abundance. When nearly one hundred sheep can be pastured from the closing days of April to the opening days of November on ten acres of such forage, as was done in 1897 at the Minnesota University experiment farm, the possibilities in live stock production in our republic light up with a peculiar brightness. When it is remembered that the soil was sandy, that the subsoil was sand or gravel or a mixture of the two, that the land had been but feebly fertilized, the brightness grows more radiant. And when it is called to mind that 10.33 tons of cured fodder and 10.39 tons of soiling food were also taken

from the same ten acres during the growing period of the year mentioned, and that much unused forage was plowed under as green manure, the firmament of possible production becomes all ablaze with promise. The first to look at those happy indications will probably be the first to engage in growing forage crops.

Plants Discussed.—The plants discussed in the book include those which can be grown for forage in any part of the tillable areas of the United States and Canada, grasses excepted. Some varieties, however, but little known, or of only local value, are doubtless not included. The attempt has been made to classify or group them in the hope of rendering the discussion more simple and concise. But in the absence of a guide, it is possible that some exception may be taken to the classification adopted. It is based largely on family relationships and, to some extent, on similarity of treatment required in growing them.

In discussing the various plants considered, it has been the aim to give them space in the order of their relative importance. But it was not in all instances found practicable to do so, and for the reason that the relative importance of several of these plants has not yet been determined. Experience in growing them has also been so limited that some time must yet elapse before such experience will be forthcoming. In the judgment of the writer, a great future awaits the growing of vetches for forage and soiling food in our country, but at the present time the growth of these crops is greatly circumscribed. Their adaptation, therefore, to certain localities is, in the meantime, a matter of con-

jecture rather than one of fact. And the same may be said of certain other crops.

In addition to the various plants that are discussed in the book, a chapter is written on succession in forage crops, and also one on sheep pastures at the Minnesota University experiment farm. In the latter an exemplification is given of what is advocated in the book.

CHAPTER II.

INDIAN CORN OR MAIZE.

Indian corn *(Zea Mays)* is one of the greatest food plants that was ever bestowed on any country. It is indigenous to this continent, and can be grown, in one or the other of its forms, in nearly all parts of the continent capable of maturing cereals. There is probably no other plant at the present time that produces more food for man and beast, and that is susceptible of being grown under so great a variety of conditions.

Corn is of many varieties. They run up into the hundreds, and the number of varieties is sure to be increased. It is well that it is so, for in this way new kinds can be produced with special adaptation to the needs of the respective regions in which they are to be grown. While new varieties are thus being evolved, established varieties are continually being introduced into sections where they had not been grown hitherto, and in these sections they are being acclimatized; hence we can confidently hope that in the near future almost every part of America that can mature grain crops will be possessed of those varieties of corn best adapted to its needs.

Corn varies exceedingly in its habits of growth. Some kinds grow only to the hight of a few inches from the ground. Other varieties grow to the hight of twelve feet and more. Some varieties produce only one stalk and but one or two ears. Other

kinds produce several stalks and bear a number of ears. Some kinds produce but few leaves and much grain, other varieties grow many leaves and but little grain. Some are sweet, others much less so. Some are flint and some are dent, and others are hybrid, as it were, between these. Some kinds mature under ninety days, other varieties require many months to complete their growth. Various other distinctions appertain to the multi-form varieties of this food product. Verily, their name is legion.

At one time corn was grown chiefly for the grain product, but it is now grown more and more to provide soiling food and fodder. It is not improbable that, ere many years shall pass, the area of corn fed green and in the cured form unhusked, will much exceed the area that will be husked. Notwithstanding the rapid increase in the growing of corn for soiling, for ensilage and for fodder to be fed in the autumn and winter, the idea of growing corn for pasture does not seem to have made an impression on the mind of the corn growers of this country. When the author sought information on this point, in 1894, prior to taking up the work of experimenting in growing corn for sheep pasture, none could be found. It may be that the search was too narrow and restricted, but the fact stated will make it clear that at that time information on the point at issue was not plentiful. It is of this particular feature of corn production that the present chapter will treat. A view of sheep pasturing on first growth of corn and rape at the Minnesota University experiment farm is seen in Fig. 2.

While it is more than probable that corn will never become generally popular as a pasture for

Fig. 2. Sheep Pasturing on First Growth of Corn and Rape.
—Minnesota University Experiment Farm.

other classes of domestic animals than sheep, nevertheless there are circumstances under which it may be fittingly grown to furnish grazing for cattle. In the upper Mississippi basin and the country lying still further north, grasses are much prone to lose their succulence in the early summer, and frequently they do not regain it again the same year. In these areas much wheat is grown from year to year on the same land. As a result, the lands become foul, and must be occasionally summer fallowed to clean them. It is while summer fallowing the land that corn may be thus grown to provide pasture for cattle or horses not at work. While the cattle are grazing the corn much of it will be broken down and fouled, so as to be unfit for food. Notwithstanding, much pasture relatively can be thus furnished per acre. And when the plow immediately follows the grazing, as it ought to, the uneaten portion of the corn plowed under will very materially increase the power of the land to hold moisture during the years following. The land will thus be cleaned and supplied with humus in the one season, and much pasture will have been secured at no added cost, other than that of the seed. This method of growing corn forage is applicable to all lands that are to be summer fallowed, wherever they may be located.

But it is in providing pasture for sheep that the best results are obtained from growing corn forage. At the Minnesota University experiment station the tests that have been made thus far in growing corn, alone or in combination with other forage plants, to provide food for sheep, have been decidedly encouraging. Further reference will be made to these experiments in the closing chapter. The waste in pasturing

corn with sheep is very little, as compared with the waste in pasturing it with cattle. And, in providing pasture for this class of live stock, it may be successfully grown wherever sheep are kept in the arable portions of the United States and Canada.

The greatest obstacle in the way of growing corn for pasture lies in the cost of the seed, which in some seasons is a considerable item. But this cost is offset in the abundance of the pasture furnished, and in its timeliness.

Distribution.—Corn can be grown successfully for forage in any part of the United States that is susceptible of cultivation. As would naturally be expected, some sections are much more favorable than others to its production; but there is no state in the Union in which at least one crop of pasture cannot be grown every season, and in some of the states two or more crops can be grown in succession. The states included in what is known as the corn belt have a most decided advantage in growing corn for the grain product; but in growing it as forage, the advantage is materially lessened. Since a corn crop will reach a stage sufficiently advanced for being pastured off in from six to ten weeks from the time of sowing the seed, according to the weather, the period of growth is quite long enough to admit of growing a crop of corn forage as far north as Lake Winnipeg. Corn wants heat and moisture to produce it quickly, and in nearly all the tillable portions of the United States and Canada there is enough of both to produce a maximum crop of corn that will become sufficiently advanced for being eaten down before the coming of the cool weather of autumn.

Inland from the oceans, the average heat of the

days during the summer months is not much less than the average much further south; hence corn grows almost as quickly at that period in the northern states as in the states included in the lower Mississippi basin. But in the states that lie along the northern boundary, the whole season of growth is so short that the large and slow-maturing varieties of corn cannot always be ripened in the areas adjacent to the Canadian border. Nor can the ripening of some of the small varieties always be depended on. But there is always time enough to grow a crop of corn forage, and to pasture it off before it is liable to be stricken down by frost.

In the northern states in proximity to the sea, both east and west, the period without frost is longer than with the states inland, but the summer heat is also less, more especially on the Pacific side of the continent; hence the growth of the corn is much slower. It is not improbable that corn sown at the proper season at Duluth, would be as far advanced in six to eight weeks from the time of planting as the same kind of corn would be at Puget Sound in ten to twelve weeks from the time of planting.

At St. Paul, Minn., there is ample time to grow two crops of corn to provide forage in succession on the same land in the average season. In the Gulf states, therefore, there should be ample time to grow as many more crops in succession within the year, providing ample moisture is present. Hence, in this way in the "sunny south" a very large quantity of corn forage could be obtained in one season from a piece of land.

In portions of the semi-arid region adjacent to the Rocky mountains on the eastern side, corn forage

can assuredly be grown and turned to good account. *The reference here is to much of the tillable land* in the region named that cannot be supplied with irrigating waters. Some moisture is precipitated on these lands every winter and spring. Now, if the land has been plowed in the autumn previously, and if pains is taken to so stir the surface of the ground in the early spring that the ground moisture will not escape by evaporation until the season has come for corn planting, the moisture thus retained in the soil is likely to grow a good crop of corn forage. If not eaten off when grown, it will cure on the ground when the moisture fails; but still it will provide much food.

Place in the Rotation.—Corn for forage may be given any place in the rotation. First, it may with propriety be made to follow a cereal crop that has been grown on foul land which requires to be cleaned. Or, second, it may follow a hay or pasture crop when the presence of vegetable matter in the soil is an important consideration. Or, third, it may with peculiar fitness be grown as a catch crop. When grown as a catch crop, it may come after rye that has just been pastured off; after any kind of spring grain that may have failed to grow; after a stand of grass pastured off early, but that is not good enough to retain; after winter oats, or crimson clover that has been eaten down or harvested; or, where the season is long enough, it may follow rape eaten down. There may also be instances when it would be prudent to sow corn again, although the principle of thus growing two crops upon the same land in succession is not a good one. And it may, with much propriety, be sown on the bare fallow.

The crops that should immediately follow corn sown for pasture will depend somewhat on the fact as to whether other plants have been grown with the corn and, to some extent, on the character of the plants so grown. When the corn is sown alone, it may fitly be followed the same season with winter rye and rape to furnish fall pasture, or with crimson clover or winter wheat, according to the locality. But it will not avail to sow these crops unless there is sufficient moisture in the soil to sprout the seed. A crop of corn growing thickly, as for pasture, is mighty to pump water out of the soil. When sown with such crops as rape, cowpeas or vetches, these crops will furnish more or less pasture after the corn has been eaten down. The amount of the pasture thus furnished will, of course, be largely dependent upon the amount of moisture that falls late in the season. The natural order the next year will be a grain crop where some crop has not been sown after the corn that is to live through the winter.

Soil.—The soil best suited to growing corn for pasture will be much the same as that best suited to growing corn for other uses, that is to say, it will be a deep, rich, mild, moist, friable loam. If well supplied with humus, the condition will be further improved. The decaying humus furnishes readily available plant food and also much increases the power of the soil to hold moisture. Stiff clay soils may be made to produce strong crops of corn when the season is favorable and when the plants get a good start, but it is usually at an expenditure of much labor in preparing the land. Moreover, the corn grows slowly on these, and in a dry season it is not likely to prove a success. Light, sandy soils are

not good, unless they have been artificially enriched. The same is true of gravelly soils low in fertility, and when these poor soils lie on a subsoil of sand or gravel, the condition is still less hopeful. And, if it should become dry, it is still further aggravated. Peat soils are not good in a dry season. Muck soils are excellent when moist, and the same is true of the average dark colored soils of the prairie and of the gray soils of the Rocky mountain region. Hardpan subsoils that come near the surface are not good. They prevent the corn roots from getting down into the soil, and corn naturally ransacks the soil for food, both near the surface and down from it. Subsoils in which the water table lies quite near the surface are not good, since they hinder the downward course of the roots; nor will corn grow in saturated surface soils. Mild clay subsoils are considered the best, since the moisture does not filter too quickly through them, and the roots of the corn can easily penetrate into them in search of food.

Preparing the Soil.—When preparing the soil for corn that is to be sown for pasture, the aim should be to secure a deep, firm, finely pulverized, moist and clean seed bed. Sometimes, as, for instance, when the ground is plowed the autumn previously, all these conditions can be secured. At other times some of them only can be reached, owing to the too limited period for giving it the necessary cultivation. When the ground is plowed in the autumn, the plowing should be deep. It should be deep to enable the young roots and rootlets of the corn to penetrate it easily during the earlier stages of growth and to give the soil power to retain more moisture near the surface. And the aim should be to plow it in the fall,

that time may be given for the upturned soil to become warmer than it would be if spring plowed, through the influence of the sun shining on it and of the warm rain penetrating it. Second, to give time for weathering influences, as that of frost, to operate upon it, so that inert fertility will be unlocked and made available. Third, that the seed bed will be given time to regain its former density. And, fourth, that ample time may be given to sprout the weeds on the surface before sowing the corn. This can be done by running the harrow or cultivator over the surface of the soil as soon as the ground is dry, and by using the harrow again and again on the same soil as often as the weeds have sprouted in considerable numbers. It is very important that this shall be done even on fallow land that is to be sown with corn. In addition to the cleaning of the land, the soil moisture will be retained in it. But in some localities, especially those in which the soils are essentially clay, and where the winters are mild and rainy, it may be unwise to plow the land in the fall, lest it assume an impacted and clammy condition that would seriously interfere with and hinder the operations of tillage. Under these conditions the land should be plowed as early as possible in the spring and subsequently managed like fall plowed land up to the time of sowing the corn.

When the corn is to follow rye or crimson clover or winter oats, or any other crop that has been grazed off in the spring, or grain that has been sown and failed to make a stand, the depth of the plowing should be regulated by the composition of the soil, its present condition as to moisture, and the general character of the climate. The more clay the soil con-

tains, so long as it may be classed as a loam and not a clay soil, the moister its condition. The more humid the climate and the more frequent the showers, the more deeply may the land be plowed, and vice versa.

When light and springy soils are plowed deeply in the spring, they lie so loosely upon themselves that there is much loss by surface evaporation. The same is true of these soils, but in a less degree, when they are plowed shallow in the spring. And the drier the climate, the more aggravated does this condition become. As soon, therefore, as such lands are plowed in the spring, they should be at once rolled. The aim should be to roll them the same day that the plowing is done. The pressure of the roller lessens the surface evaporation. But the rolled surface should ere long be followed by the harrow, to hinder the soil from lifting with the wind, as it does in certain sections of the prairie, and to create a more perfect dust blanket, that will hinder the escape of ground moisture. Cloddy surfaces should be made fine by the use of the roller and harrow.

The best time for applying fertilizers will be dependent upon conditions, as, for instance, the season of the year at which the plowing is done. When the land is plowed in the fall, farmyard manure should then also be applied, when on hand. It should be plowed under, except in leechy soils, and where the rainfall is heavy in winter. On such soils it should be applied on the surface, and in the composted or reduced form when spread on fall plowed soil. It may then be incorporated with the soil in the spring by the aid of the disc or some other form of cultivator. When the land is spring plowed, the

manure may be spread in the winter or at such other time as may be convenient, up to the season when the land is to be plowed. When moisture is abundant, fresh manure may be applied, providing it is buried to a sufficient depth and with sufficient care to prevent it from interfering with the proper sowing of the seed. But in dry climates, fresh and long manure should not be thus buried in the spring, lest it should keep the land so open and loose that the manure will not decay.

Potash as a commercial fertilizer may be applied any time previous to the sowing of the crop, phosphoric acid shortly before or when the crop is sown, and nitrogen when the crop is sown or subsequently, but before the plants have reached an advanced stage of growth. The first may be incorporated with the soil as may be convenient. The second should be incorporated with the surface soil, and the third should be similarly incorporated, or, what would be preferable, sown upon the surface.

Sowing.—The seed should not be sown until reasonable danger from frost is past, until that season has arrived when fairly warm weather may be looked for, or until the ground has become warm. A slight frost, however, that only nips off the tops of the blades may not work very serious harm. Corn for pasture may be sown,if desired, a few days earlier than corn grown for other uses. Owing to the thick character of the sowing, though a proportion of the plants should fail, they will not be seriously missed from the crop. And it may be sown far on into the summer, according to climatic and other conditions.

As to the mode of sowing corn for pasture, something will depend upon the facilities at hand

for sowing it, and something upon the combination of the seeds sown along with it. Sowing it broadcast, however, is to be deprecated, since some of the seed will not be covered by the harrow. And if a shower of rain should fall soon after the seed is sown, much of it would be washed bare, thus increasing the percentage of the seed that would perish from exposure to air and sun. And when the harrow was run over the crop subsequent to the sprouting of the corn, many of the young plants would be disturbed in their growth, if not, indeed, killed outright. Nevertheless, such harrowing may be done with profit when a plentiful supply of seed has been sown. The aim should be to plant the seed with the grain drill deeply in loose-lying soils, as deeply as three inches, and less deeply in heavier loam soils.

When cowpeas or vetches are planted along with the corn, the seed should first be mixed with that of the corn. When rape is sown, it may be broadcasted before the corn is sown. The drill tubes are likely to give it sufficient covering when the corn is being planted. Or it may be sown just when the first blades of the corn appear, and covered with the harrow. The first method is preferable where the corn is to be given more than one harrowing. But in such instances, the rape seed should be sown thickly, to allow for the loss of plants that will result from using the harrow.

The amount of seed to sow will depend upon the soil, upon the kind of corn, and upon the other kinds of forage sown along with the corn. Soils low in fertility should be given a thick seeding to increase the sum total of the forage produced. Soils very rich should also be sown very thickly, to produce

forage less coarse than would result from thin sowing. And intermediate quantities of seed should be sown on intermediate soils. Varieties of corn with a large seed kernel should be sown more thickly than those with a small seed kernel. And those kinds that are naturally of a leafy habit of growth should be sown more thinly than those opposite in character. The larger the proportion of other seeds sown along with the corn, the less will be the proportion of the seed corn required. When corn is sown to provide forage without intermixture of other seeds, the quantity of seed to be used will range from one to three bushels per acre. When sown in combination with other forage plants, the proportion of corn may be reduced as low, in some instances, as one-half bushel per acre. Equal quantities of cowpeas and corn sown together would answer well in some localities. The proportions of two parts corn and one of vetches would answer well in other localities, and Dwarf Essex rape seed sown with the corn, or with the corn and vetches, at the rate of two and three pounds of the seed per acre, should further improve the pasture. And when the corn had all disappeared, in consequence of the grazing, the other plants would, under certain conditions, make a good second growth. But the proportion of the seed of the respective plants used that would best meet the requirements of each locality can be fully ascertained only by actual test. A field of second growth of rape sown with corn is seen in Fig. 3.

Cultivation.—When the corn is sown alone, it will be greatly benefited by harrowing it judiciously at least two or three times from the period of sowing the corn and the period when it shall have attained

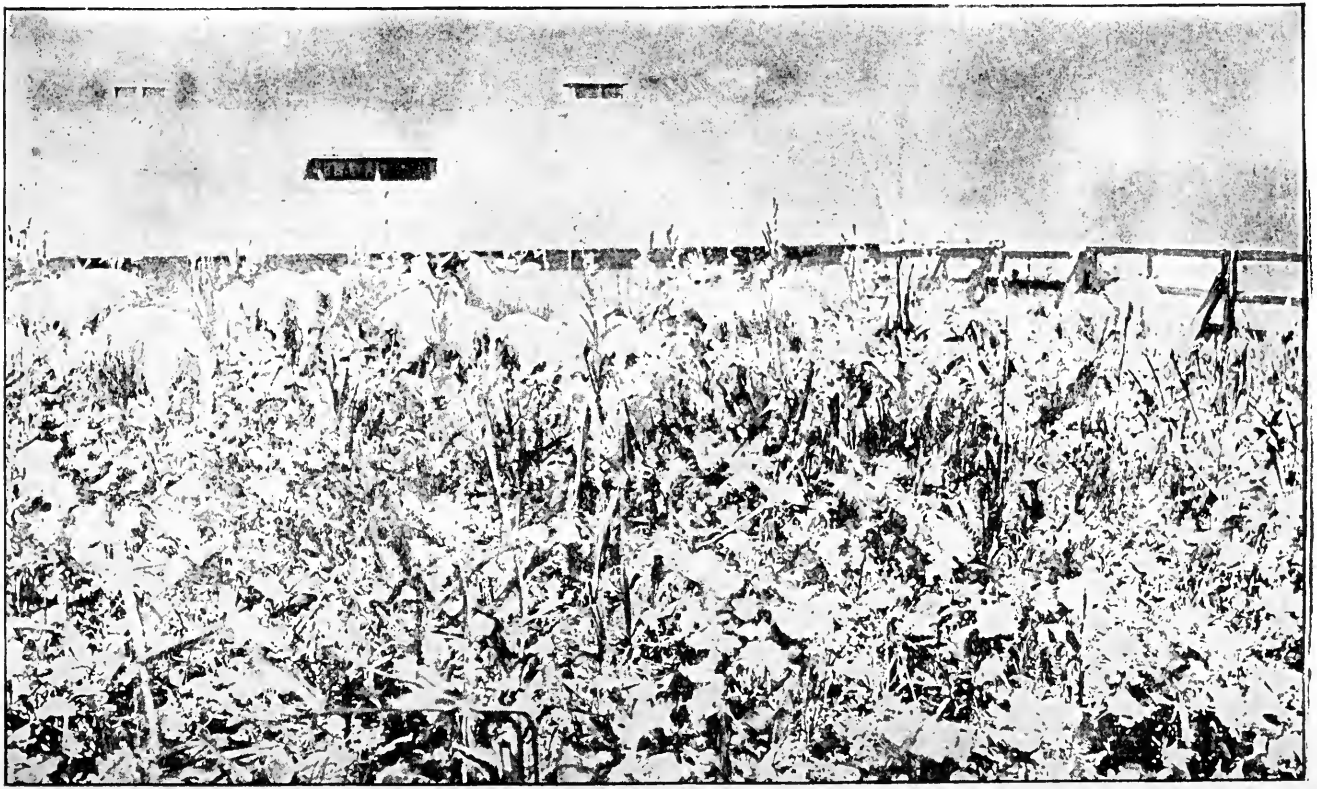

Fig. 3. Second Growth of Rape Sown with Corn.
—Minnesota University Experiment Farm.

the hight of four to six inches. By judicious harrowing is meant, using a light harrow, adjusting the teeth to a backward slant that will hinder them from cutting too deeply and too erectly, and using it when the land is not overmoist. When the harrow teeth are used in an erect position, they tear out too much of the corn. As soon as the seed has been sown, the roller may, in nearly all instances, be made to follow the drill with much advantage. It presses the particles of soil more closely around the seed, lessens the degree of the exposure of the seeds to the light, and lessens the drying out of the soil; hence the quick germination of the corn will be greatly facilitated, unless where moisture is abundant. On soils that lift with the wind, the harrow should soon follow the roller, and in any case the crop should be harrowed before the corn has appeared. The other harrowings, of course, come later. But when other plants are sown with the corn, one harrowing given before the plants are up may be all that can be given without hazard to the plants.

Pasturing.—When pasturing corn with cattle or with sheep, it should be allowed to make a good growth before the animals are turned in to graze it down, as it does not sprout up again. The grazing should commence when the plants are from eighteen to twenty-four inches high. But where the promise of forage is so abundant that the supply is likely to be quite beyond the requirements of the live stock that are to be grazed upon the corn, the pasturing should begin somewhat earlier, unless in instances in which the residuum of waste from the pasturing should be looked upon as an important factor when plowed under for improving the land. Care should

be taken not to turn the animals in to graze when they are hungry, at least at the beginning of the pasturing, on the principle that sudden changes of diet are not good. But corn is not so much liable to produce bloating as some other kinds of green forage, nor should the animals be pastured upon it when it is wet, as then they foul the feed and impact the land too much with their treading, and in the case of sheep the fleeces would become more or less saturated with water.

As already intimated, there will be much waste from treading by cattle, so much that it would not seem profitable to graze them on corn, unless when the residuum of waste forage to be plowed under just after the pasturing, is looked upon as an important factor. But when sheep are pastured upon corn, the waste is not nearly so great. They do not break down nearly so much of the corn as cattle, and much of what is broken down they will consume in the cured form.

Observations.—The chief strength of corn as a forage plant lies, first, in the quickness with which it will grow; second, in the large amount of forage which it produces; third, in the succession of the crops that can be grown the same season; fourth, in the combinations in which it may be grown; and, fifth, in its power to grow under dry conditions. Its weakness as a forage plant lies, first, in the cost of the seed; second, in the fact that it will not grow again when grazed off; and, third, in the considerable proportion of the waste when grazed off by cattle.

2.—The work of grazing corn as a pasture must be regarded as being only in the experimental stage. And it would seem to be important that the combina-

tions in which it can best be grown, as adapted to different localities, should be made the subject of careful experiment in the near future.

3.—It is at least possible that in the dry regions of the northwest, east of the Rocky mountains, some small varieties of corn, as, for instance, squaw corn, may yet be grown to provide what may be termed finishing or fattening food for range sheep grown on the adjacent lands. Squaw corn will mature anywhere within the area named. Although possessed of a low, bantam-like habit of growth, it branches out considerably, and produces much grain in proportion to the stalk. It may be best grown on fall plowed lands, managed in the spring with a view to conserving moisture. It should then be sown with the grain drill, care being taken to put the rows not so distant as when planting larger varieties of corn, and to give the crop proper cultivation. The sheep should then be turned in upon it in a prudently cautious manner at first, to graze it down and to fatten upon it before the closing in of the winter. In the absence of conclusive tests, judgment should not be pronounced hastily as to the value of this theory, for in practical agriculture we can never be quite sure of the exact value of a reasonable theory until it has been fairly tried. But it may be proper to mention here, that experiments conducted at the Minnesota University experiment farm, but not yet completed, have proved decidedly encouraging in character.

4.—The pasturing of corn stover yet standing where it grew, is to be deprecated. Corn stover, as is generally known, is corn from which the ears have been removed. It is to be deprecated, because of the wastefulness of the process. The stover dries so

much after maturity that a great deal of the nutriment in the stalk is lost before the corn is eaten. Because of this overcuring, the palatability of the corn is greatly lessened; hence much of it will not be consumed. A large proportion of it becomes broken down and fouled, which causes still further waste. And the cattle are oftentimes required to graze upon it when the weather is unfavorable, hence there is a loss from thus exposing the animals. Of course, it is better to pasture the corn thus than not to pasture it at all. But the stover would furnish much more food if it were harvested and fed to other animals as needed. The prodigality of some of the western farmers of this country finds a striking illustration in this wasteful method of handling, or rather not handling, corn stover. Each acre of the food, if properly utilized, is worth as much as an acre of average timothy hay.

CHAPTER III.

SORGHUM.

Sorghum *(S. vulgare saccharatum)* was introduced into the United States from China, and also from South Africa, more than forty years ago. For many years it was grown only for the syrup made from its juices. But within the last decade, and even for a longer period, considerable attention has been given to growing it as a food for live stock in certain centers and in various sections of the country.

It is a wonderful plant. It can be grown to provide cane for making syrup in every state in the Union. It is one of the best soiling foods that we have. It furnishes fodder of an excellent quality for live stock, when fed in the autumn and winter, more especially the early winter, and it is one of the best forage plants that we shall ever have. The seed of sorghum can also be turned to good account as food for all kinds of domestic animals kept upon the farm. But it is as a forage plant that it will be discussed at this time. Sorghum grown for fodder is seen in Fig. 4.

Although this plant, as just intimated, has hitherto been grown chiefly for the syrup which could be extracted from it, in the near future it is more than probable that a much larger area will be grown to furnish food for live stock than to furnish syrup. In some of the states in the Mississippi basin, on both sides of the river, in the Gulf states and in Texas,

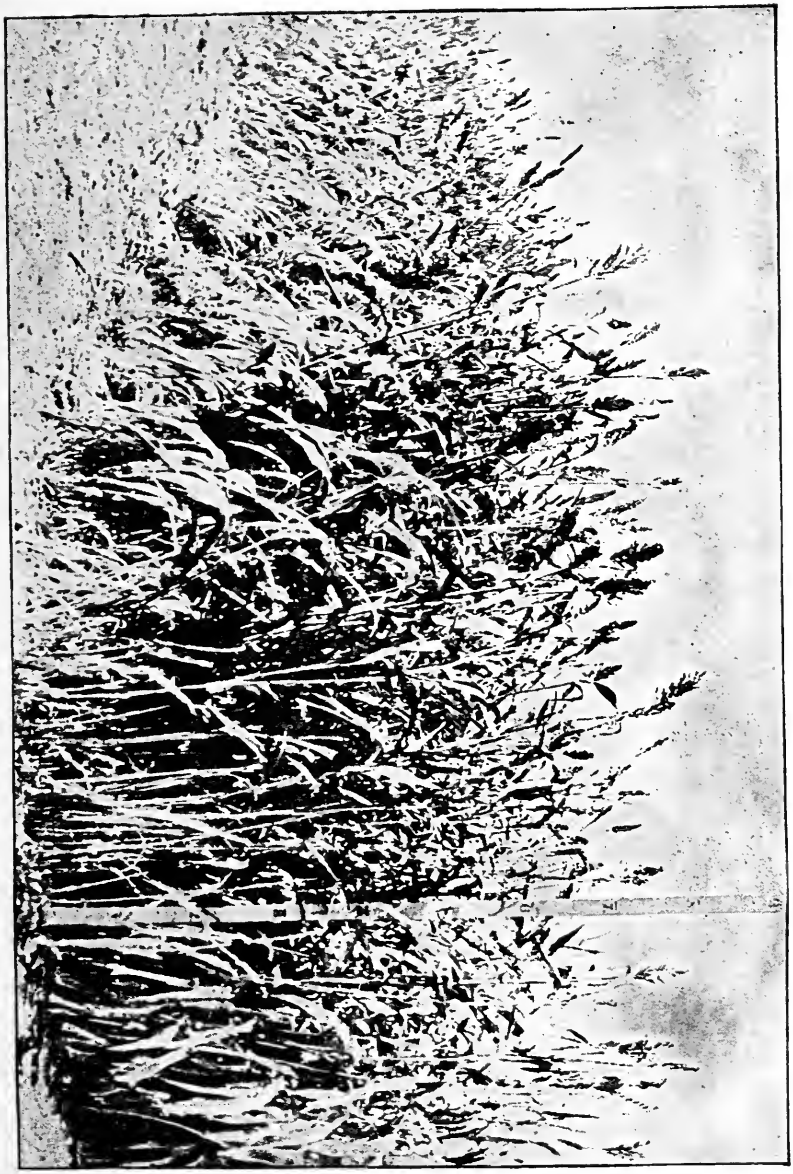

Fig. 4. Sorghum Grown for Fodder.
—Minnesota University Experiment Farm.

more or less of it has been grown for years to provide forage for cattle and swine; but, so far as known to the author, it has not been grown until recently as forage for sheep; and yet there is no other class of live stock which are capable of turning sorghum pasture to better account. During the winter of 1893-4 the author sought diligently for information as to the adaptability of sorghum as a pasture plant for sheep, but found none. In not a single instance, by correspondence or otherwise, was anyone found who could give a line of information as to the value of sorghum for sheep pasture. Doubtless, there were those who had tried it, but the fact just stated will show how little was known at that time as to the value of this most wonderful forage plant in providing pasture for sheep. As an all-round food producing plant corn is quite ahead of sorghum, but as a forage plant sorghum is quite ahead of corn. It is at least questionable if we have a forage plant in the United States that is so well adapted for being grown over so wide an area.

Sorghum is pre-eminently a summer pasture. Blue grass and various other grasses slumber during much of the summer. Medium red clover languishes, especially in the south, where midsummer suns wax warm. Rape becomes crisp and faded at that season, if sown early, unless under exceptionally favorable conditions as to moisture. Mammoth clover has done its work for the year, and the same is true of alsike. These two take a rest after harvest, and as a pasture in the autumn they are like the deceitful water brooks that have dried. Then it is that sorghum is at its best. Being a child of the sun, it strikes its roots downward and pushes its leaves upward and

outward through all the hot season, thus furnishing an abundance of succulent pasture at a time of the year when it cannot so well be obtained from any other source.

There are two distinct classes of sorghum, known as the saccharine and the non-saccharine, respectively. This classification is based on the presence of sugar in considerable quantities in the matured cane or on its almost entire absence. The first of these only will be discussed in the present chapter. Of the saccharine sorghums there are many varieties, but for forage uses two of these are more extensively grown than the others. These are the Early Amber and the Early Orange. The former, with its sub-variety, the Minnesota Early Amber, is grown in the northern and northwestern states to the almost entire exclusion of other varieties. And the latter, with what is probably a sub-variety, the Kansas Orange, is extensively grown in the south and southwest. Folger's Early is also a favorite in growing forage, but it also is grown in the southwest and south. But in all-round adaptation, it is questionable if any of the other varieties excels the Early Amber and its sub-variety in the production of forage. The Amber varieties are hardy, they furnish an abundance of leaves, they have a high sugar content, and they mature earlier than most other varieties.

When sorghum first appears above the surface of the ground, it is a tiny plant bearing a close resemblance to foxtail *(Setaria glauca)*, or, as it is sometimes called, summer grass or pigeon grass. It grows slowly at first, and is easily pulled out or injured by treading when live stock graze upon it at too early a period. But after it has reached the hight of several

inches, it grows very rapidly. When less than a foot high, sorghum forage is a mass of leaves, and makes a decidedly beautiful appearing forage crop. When a foot high or thereabouts, it joints and sends up stems or canes with much quickness. In grazing it off therefore, especially with sheep, it is important that it is eaten down before the crop has reached the stage when it is common to begin to cut it for soiling, that is to say, while it is not yet more than from one to two feet high. When grazed down, it at once springs up again. The pasture is likely to be thicker in the second growth than it was in the first, because of the increased number of sprouts that spring from the root.

Sorghum has much power to withstand dry weather, when once it has become established. It will grow under certain conditions where corn would curl in the leaf and shrivel from want of moisture. In its power to grow under dry conditions it will rival Kaffir corn, and when the crop has become so imperiled through long continued drouth that it shows signs of languishing, it has much power to revive again when rain falls.

As a forage plant it is not usually grown in cultivation with other forage plants, and for the reason, first, that when sown thickly it fully occupies the ground, and, second, that it at once begins to grow again when eaten down, thus rendering it unnecessary to sow a crop along with the sorghum to furnish forage after the latter has been grazed off. But some forage plants may be sown along with it to provide a variety in the pasture. These will be referred to again.

Distribution.—There is probably no plant

grown on this continent that has a wider range of distribution than sorghum. It can be grown for forage with much success in nearly all parts of the United States where the land can be tilled. And in no part of the Union where crops are grown can it be said to be a decided failure. It can also be grown with more or less of success in every portion of Canada that has been disturbed with the plowshare.

Notwithstanding this wide range of adaptation, there are certain areas where its mission as a forage crop will be vastly more important than in other areas. The areas which will be most benefited by growing sorghum are those in which the summer temperature is warm, where the rainfall is fitful and insufficient, and where the winters are mild enough and sufficiently dry to admit of feeding sorghum out of doors, or of grazing it off where it grew. And the areas that will profit the least by its growth are those with much moisture and comparatively low summer temperatures. Moisture is of course not antagonistic to the growth of sorghum. On the contrary, it is favorable, but where the mean temperature in summer is low the sorghum grows too slowly. And cool and moist climates are so well adapted to the abundant production of grasses and certain other forage plants that in these sorghum pasture is much less needed.

The states therefore that are likely to profit most by the growth of sorghum for forage are those that lie on the border of the semi-range country to the west, as, for instance, South Dakota, Nebraska, Kansas, Oklahoma and Texas. And those that will profit least by its growth are those parts of Washington and Oregon that lie west of the Cascades.

A wonderful field lies open for the growth of sorghum in all the states which border on the Mississippi and Ohio rivers, and also in the lower Atlantic and Gulf states. In New England and the adjacent states it will also be freely grown. But in the Rocky mountain states, although it has a mission, it is less important than that of their great forage plant, alfalfa. The best adaptation for sorghum pasture in Canada is found in southern Ontario, but it will also grow well in other sections. And the least adaptation probably will be found for it in British Columbia.

Place in the Rotation.—The place given to sorghum in the rotation will be much the same as that given to corn; hence nearly all that was said of corn under this head will equally apply to sorghum. (See Page 15.) Like corn, it may fitly be made to come after a cereal crop when the land is foul, after winter rye, winter oats, rape or crimson clover, when one or the other of these has been pastured off; or, in southern latitudes, after a crop of early matured market products. Figure 5 shows a crop of sorghum and rape, the third crop grown on the land for the season, and Figure 6 a crop of sorghum and rye. The order in these crops was, rye, sorghum, sorghum and rape. It may also be sown as a catch crop on lands that are being summer fallowed. Sorghum pasture should in a sense be made a cleaning crop; hence it may best be followed in the regular rotation with some cereal. But when a succession of forage plants is wanted in the rotation, sorghum may be followed with winter rye, or winter oats.

Soil.—The soils that are best suited to the growth of corn are also those that are, in the main,

Fig. 5. Sorghum and Rape.
—Minnesota University Experiment Farm.

best suited to the growth of sorghum. (See Page 16.) But as sorghum has greater power than corn to gather food from the soil, it is not so necessary to have it in a high state of fertility. And yet it is true of sorghum, as of corn, that the return in the crop will usually be proportionate to the richness of the land. This is particularly true of sorghum forage. But it is not so essential in growing sorghum that the land shall be well stored with nitrogen as that it shall be well stored with phosphoric acid and potash. The idea has obtained currency that, because several crops of sorghum have been grown successively on the same land in certain instances, that sorghum is not hard on land. That simply proves that these soils possess a wonderful adaptation for growing sorghum. To say that any crop which produces grain, other than a legume, is not hard on land is simply absurd. But since sorghum feeds more deeply than corn and, moreover, since it has greater power to gather food in the soil and subsoil, good crops of sorghum may be grown on land too low in fertility to produce good crops of corn. The best soils for sorghum are free-working, moist, sandy loams underlaid with a mild porous clay subsoil, rich in the elements of phosphoric acid and potash. Humus soils are good, but not so good relatively as for corn. Hard clays lying on harder subsoils are quite unfit for growing sorghum. This plant will also grow on soils possessed of more or less of alkali. But, beyond a certain degree, the presence of this element would be fatal to its growth.

Preparing the Soil.—It is even more important with sorghum than with corn that it shall be sown on land thoroughly pulverized and with moisture com-

Fig. 6. Sorghum and Rye, Third Crop.
— Minnesota University Experiment Farm

ing up near to the surface, since sorghum plants are more delicate when young than corn plants. In order to clean the land, therefore, it is essential, first, that it shall be plowed in the fall or in the early spring, and, second, that it shall be occasionally stirred on the surface with harrow or cultivator from the opening of spring until the sowing of the seed. It is evident, therefore, that the longer the period between the dawn of spring and the sowing of the seed, the better is the opportunity given to clean the land. And that this process may be secured in a more complete degree, it may be a wise plan to defer sowing the sorghum for a week or two or even for a longer period.

But when sorghum is to follow a crop of forage, as, for instance, winter rye, crimson clover or winter vetches, there will not be sufficient time to clean the land in best form before the sowing of the sorghum seed. And here, also, it may be wise in some instances to defer sowing the sorghum immediately, that opportunity may be thus given to secure a more perfect degree of cleanness in the land. But the seasons are in many places too short to admit of so doing, and in many other places they are too dry. In any event, as soon as the land has been plowed after one of these pasture crops, it should be at once rolled, to keep in the moisture. And before the seed is sown the pulverization of the soil should be thorough. Too much care cannot be taken when preparing a seed bed for sorghum.

Substantially the same manures and fertilizers may be supplied for sorghum as for corn, and by the same methods. (See Page 19.) As previously intimated, nitrogenous fertilizers are not so essential for sorghum as for corn.

Sowing.—Sorghum should not be sown until the weather has become decidedly warm. No good can result from sowing it sooner, even though the seed should germinate. It will not make any marked advance in growth until the arrival of settled warm weather, and if kept practically standing still after it has sprouted, it would seem to lose much of its natural power to grow on the return of weather favorable to its progress. Sorghum sown late, under favorable conditions as to growth, will produce more and better forage, and at an earlier period, than sorghum sown several weeks earlier, but which has been severely checked in its growth by weather unduly cool. This has been demonstrated more than once in the experience of the author.

Of course, no date can be fixed upon for sowing sorghum that would be equally applicable to all parts of the country. Nor would it be applicable to sections on the same parallel of latitude. The mean temperature, as is well known, differs widely with a difference in altitude and a difference of distance from large bodies of water. No better rule probably can be given for sowing sorghum than that which would invariably delay sowing until toward the close of the corn-planting season. And where there is moisture enough to produce a crop of forage the sowing may be continued in warm or mild latitudes until within eight to ten weeks of the arrival of frost. Frost will injure sorghum more readily than corn, hence the aim should be to delay sowing until the spring frosts have disappeared, and to have the crop eaten off by the time that the autumn frosts arrive.

Sorghum is frequently sown broadcast to provide soiling food and also winter fodder. But this

mode of sowing it, as compared with drill sowing, not only calls for more seed, but is attended with greater hazard. It calls for more seed because of the imperfect covering given to the same by the harrow. In dry, hot weather that portion of the seed lying near the surface will not germinate, even though the ground should be moist below. And when the crop is harrowed, more plants will be torn out by the harrow than if the seed had been sown with the drill. The hazard is also greater for the reason that, if dry weather should follow the season of germination, the plants that have rooted nearest the surface will be the first to suffer. But in the absence of a seed drill it may be thus sown with the expectation that ordinarily many of the seeds will fail to produce plants, hence much seed ought to be sown.

There is no better mode of sowing it than with the grain drill. When thus sown, ordinarily all the tubes should plant seed. But in areas where moisture is wont to be scant, every alternate tube only should be in use. The seed should not be covered deeply, never more deeply than one and one-half to two inches, as in the black humus soils of the prairie, and less deeply in soils of heavier texture. When sown late in the season and the weather has turned dry, it may also be well to close up some of the drill tubes, lest there should be too many plants for the moisture. The number of these can, of course, be reduced by running over the crop with the harrow, with no other cost than that of harrowing, and no other waste than that of a portion of the seed. This mode of sowing the sorghum would be especially applicable to semi-arid regions, where the rainfall in summer is unreliable and ordinarily insufficient to perfect a crop. The

plants will not then rob each other of moisture so readily because of their greater distance from one another.

The quantity of seed to use will depend upon the mode of sowing, the extent of the harrowing that is to follow, and the other seeds along with which the sorghum is sown. When broadcasted, from one bushel to one and one-half bushels of seed are sown per acre. When sown with the drill, the writer has found three pecks of seed per acre quite sufficient. But if the sorghum is to be harrowed more frequently than once after the heads of the young plants begin to show above ground, more than the amount stated should be sown. If the sorghum is sown along with rape seed, the proportion of the sorghum should be reduced. From two to three pounds per acre of the rape seed should suffice. By mixing in the rape seed with the sorghum seed occasionally during the sowing process, the seeds of both may be deposited simultaneously by the drill tubes. The rape seed may also be sown before the drill tubes in instances where the action of the latter would cover the rape seed sufficiently while the sorghum was being sown. The rape seed may in other instances be sown broadcast and covered lightly with the harrow at the time of sowing the sorghum seed, or when the first subsequent harrowing is being given to the crop. When sown with millet or cowpeas, the seeds may be mixed and drilled in at the same time. But on some soils the cowpeas ought to be covered more deeply than the sorghum. In such instances the cowpeas would have to be sown first and then the sorghum, at a less depth. When other seeds are added to that of the sorghum, this should be proportionately reduced.

Usually, but not always, the roller should follow closely upon the sowing of the sorghum.

Cultivation.—Ordinarily no other cultivation is given to sorghum sown for pasture than that of harrowing it once or oftener after it has sprouted. But if planted in rows sufficiently distant from one another to admit of using the cultivator, then it may be cultivated several times at proper intervals, in addition to the harrowing that may be given with much benefit just as the first blades of the sorghum begin to show above ground. But it is seldom necessary thus to sow the sorghum to furnish pasture.

When the first harrowing is given to the sorghum, it is important that the harrow shall be light and that when used the teeth are placed as far as possible at a backward slant. The harrow simply stirs the surface of the land without cutting down amid the roots of the young plants. Myriads of weeds are at the same time destroyed as they are springing into life near the surface of the soil.

Just how much harrowing sorghum will stand without harm, and just when it ought to be given, does not appear to have been made the subject of any careful experiments, the results of which have been published. It would seem probable, however, that unless an excess of seed has been sown, if a second harrowing is given, it should not be given until after the plants have made a growth of, say, five to seven inches. They will have then become more firmly rooted, hence the harrow will not so readily pull them out as if the harrowing had been given at an earlier period. In sections where the supply of moisture is insufficient or barely sufficient to produce a crop, the loss of plants up to a certain limit would do no harm.

Pasturing.—Sorghum furnishes excellent pasture for horses and mules not at work, for all kinds of cattle and for sheep and swine. As it grows up again when eaten down, it is not necessary that it shall be so far advanced as corn before the pasturing begins. When the area of the sorghum pasture is large in proportion to the stock to be pastured on it, then pasturing should begin early, and vice versa. But in no case should it be eaten down until it has made a growth of several inches from the ground, as when young and tender it is easily injured by live stock feeding upon it. At the Minnesota University experiment station good results have been obtained from turning sheep in upon the sorghum when it had reached the hight of about fifteen to eighteen inches, as shown in Fig. 6. But with the exception of a portion of the stem, sheep will graze it down when it is much higher than fifteen to eighteen inches. Cattle will, of course, break down and waste much more than sheep. Swine may be grazed upon it as early as sheep. But it is when sorghum approaches maturity and subsequently that swine would seem to be most benefited by pasturing upon it. They chew the stem and extract the nutriment from it without swallowing much of the stem.

All things considered, however, sorghum pasture is more valuable relatively for sheep than for any other kind of live stock. And to get the best results from sorghum pasture, the sheep should not be allowed to graze it off too closely. It will grow again, though grazed closely, but the growth will be slower and less vigorous than if the pasturing had not been so close. Stripping off all the leaves would seem to detract somewhat from the inherent vigor

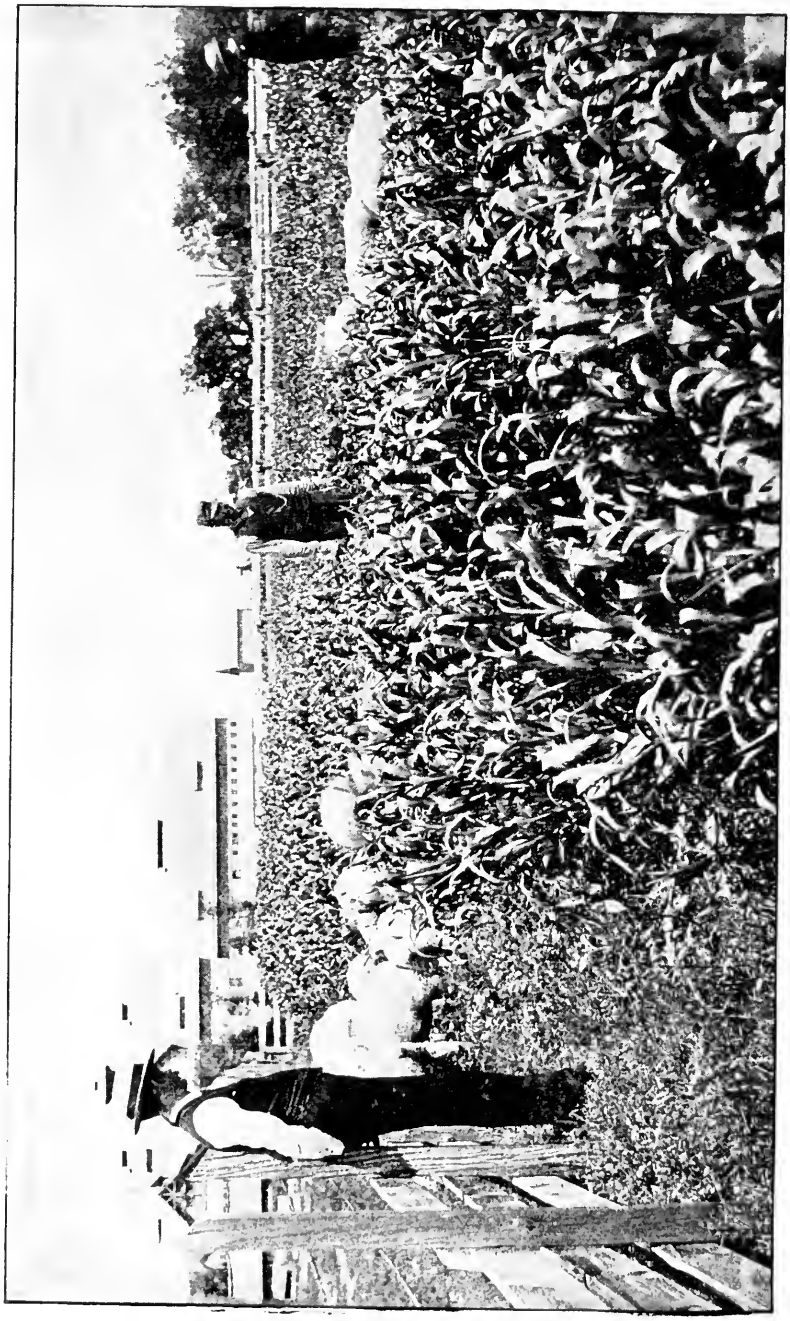

Fig. 7. Sheep Pasturing on First Growth Sorghum.
—Minnesota University Experiment Farm.

of the plant. When sorghum is grazed by sheep, more pasture will be obtained if the ground thus grazed can be divided into two or three sections and if the sheep are grazed on these alternately. Sorghum may thus be pastured off two or three or four times in a season, according to conditions of soil and climate.

Sometimes sorghum is grown, as described above, to produce soiling food, and when one cutting has been taken from it, the next or second growth is pastured off. A very large amount of forage may thus be obtained when all the conditions are favorable.

The aim should be to have sorghum grazed off before the arrival of killing frosts. It is easily injured by the frost, and when so injured live stock do not relish it. They will eat it under pressure, but do not seem fond of it.

The claim has been made that there is considerable hazard to animals, especially cattle, when pastured on second growth sorghum. At the Minnesota experiment station we have not found it so during three successive seasons of pasturing, beginning with 1895. But our experience relates only to pasturing with sheep. A view of sheep pasturing on second growth sorghum is presented in Fig. 8. The first season some fifty-three animals, young and old, were pastured on the sorghum, the second year an average of eighty-six head, and the third year an average of ninety-three head. But one animal, a lamb, was lost while feeding on the sorghum, and the cause of death in that instance arose from a lung affection, and not from eating sorghum. There are, however, well-authenticated instances wherein cattle

Fig. 8. Sheep Pasturing on Second Growth Sorghum.
Minnesota University Experiment Farm.

have died suddenly while grazing on second growth sorghum. The exact cause or causes of such loss do not appear to be well understood. It has been surmised that death has been caused by some poisonous element in the sorghum, and that frost may have something to do with thus changing the character of this splendid food. We must wait for a completely satisfactory explanation, for it has not as yet been forthcoming. In the meantime, caution should be exercised in pasturing cattle on second growth sorghum, especially late in the season.

Caution should also be exercised when cattle or sheep are first put upon sorghum pasture. There is some danger from hoven or bloat, but not nearly so much as with clover, or alfalfa. That, at least, has been the experience of the Minnesota experiment station. At the said station no instance of bloat occurred from grazing on sorghum during the three seasons of depasturing above referred to. Yet that fact is not to be taken as positive evidence that sheep will not suffer from bloat in all sections of the country and under all circumstances when pasturing on sorghum.

Sometimes cattle are turned in to graze upon the sorghum after it has matured. This practice is frequent in portions of the semi-arid country adjacent to the Rocky mountains, especially those portions of the same that have mild winters. The cattle do well on it, but the practice is a wasteful one. Yet where land is cheap and labor dear, sometimes it may be a proper thing to do. Of course, where the winters are severe the practice would be without justification.

CHAPTER IV.

THE NON-SACCHARINE SORGHUMS.

The non-saccharine sorghums are a somewhat numerous class. They are so called because of the relatively small proportion of sugar which they contain, as compared with the saccharine varieties of sorghum. Because of this, however, the conclusion must not be reached that they do not possess any sugar when matured, or that they do not possess it in considerable quantities. All the non-saccharine sorghums are more or less rich in sugar, and some of them are possessed of it in a very considerable degree.

The chief of the varieties of the non-saccharine sorghums grown in this country include Kaffir corn (Fig 9), Milo maize, Dhourra and Jerusalem corn. Teosinte is not, properly speaking, a sorghum, but it will be discussed along with the non-saccharine sorghums, because of the similarity of the cultivation required to grow it and of the uses for which it is grown. Chief among the varieties of Kaffir corn are the red and the white. There are two prominent varieties of Milo maize, named yellow and white, respectively. And of Dhourra there are also two varieties, the brown and the white. The last mentioned would seem to be identical with the plant known as White African millet. As but little, comparatively, has yet appeared in print with reference to the non-saccharine sorghums, unless it be Kaffir

Fig. 9. Red Kaffir Corn Grown for Fodder.

—Minnesota University Experiment Farm.

corn, it may be well to give a very brief description of each.

Kaffir corn, like sorghum, has an upright habit of growth, but it does not grow to so great a hight as sorghum or corn, hence it is more easily handled in the sheaf, when matured, than either of these plants. The stalks are sturdy and strong, and they taper as they grow upward, as seen in Fig. 10, showing white Kaffir corn grown for fodder. The leaves are large, long and fairly numerous, more especially in the central portion of the stalk, and they usually retain much of their greenness for some time after the maturing of the seed. The seed head is long and erect, and the production of seed is abundant. The white and red varieties are distinguished chiefly by the color of the seed head and of the seed. The white variety is later in maturing than the red, but it produces more seed.

Milo maize, in both the yellow and white varieties, has an erect habit of growth and usually attains a great hight (Fig. 11). The stems are not so stocky as those of Kaffir corn, and they are abundantly supplied with leaves inclined to fine in quality. They are the most numerous on the upper half of the stem. When once well rooted, the plants grow rapidly and produce a large amount of good soiling food or fodder. The yellow variety is distinguished from the white by the color of the seed and by some other peculiarities not of very great moment.

Dhourra (Fig. 12) grows a strong and somewhat coarse stalk; but, like Kaffir corn, it does not grow to a great hight. The leaves are broad and long, but are not so numerous as those produced by Yellow or White Milo maize. The seed head is

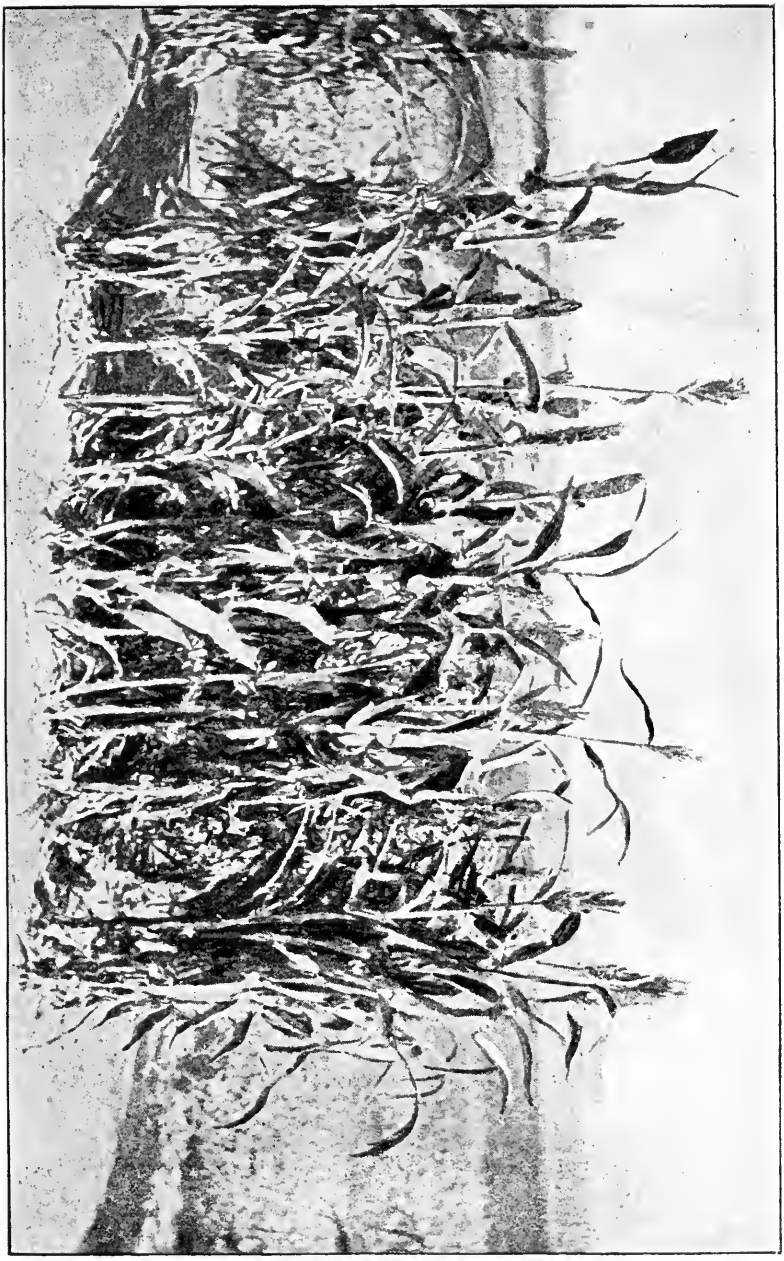

Fig. 10. White Kaffir Corn Grown for Fodder.
— Minnesota University Experiment Farm.

thick and short and oval in shape, and the production of seed is abundant. It does not produce so much fodder as Milo maize.

Jerusalem corn (Fig. 13) grows to a less hight than the other non-saccharine sorghums. The stems are heavy and the leaf growth is not abundant. The heads are large, thick and heavy, and are suspended on short stems resembling in their curve the neck of a goose. This plant would seem to be better adapted relatively to the production of seed than of fodder.

Teosinte *(Reana luxurians)* is not erect, but branching in its habit of growth. It is claimed that as many as sixty stems have been produced from one seed. The plant suckers wonderfully and produces a great mass of long slender leaves. It has been affirmed that in some of the Gulf states a greater weight of green food can be obtained from teosinte than from any variety of the non-saccharine sorghums. It grows slowly for a time, but more rapidly as the plants become older.

The non-saccharine sorghums bear no little resemblance to one another in their habits of growth. Chief among these resemblances are the following: First, the seed of each is slow in germinating, considerably more so than the seed of corn. The growth is also relatively slower for a time, although in the later stages thereof it is quite rapid. Second, the plants are more tender than those of corn when young, but when more advanced they are better able to withstand vicissitudes of weather, and more especially such as arise from drouth. Third, with the exception of teosinte, they all produce seed from a head which grows on the top of the seed stem that pushes upward from each plant. Teosinte produces

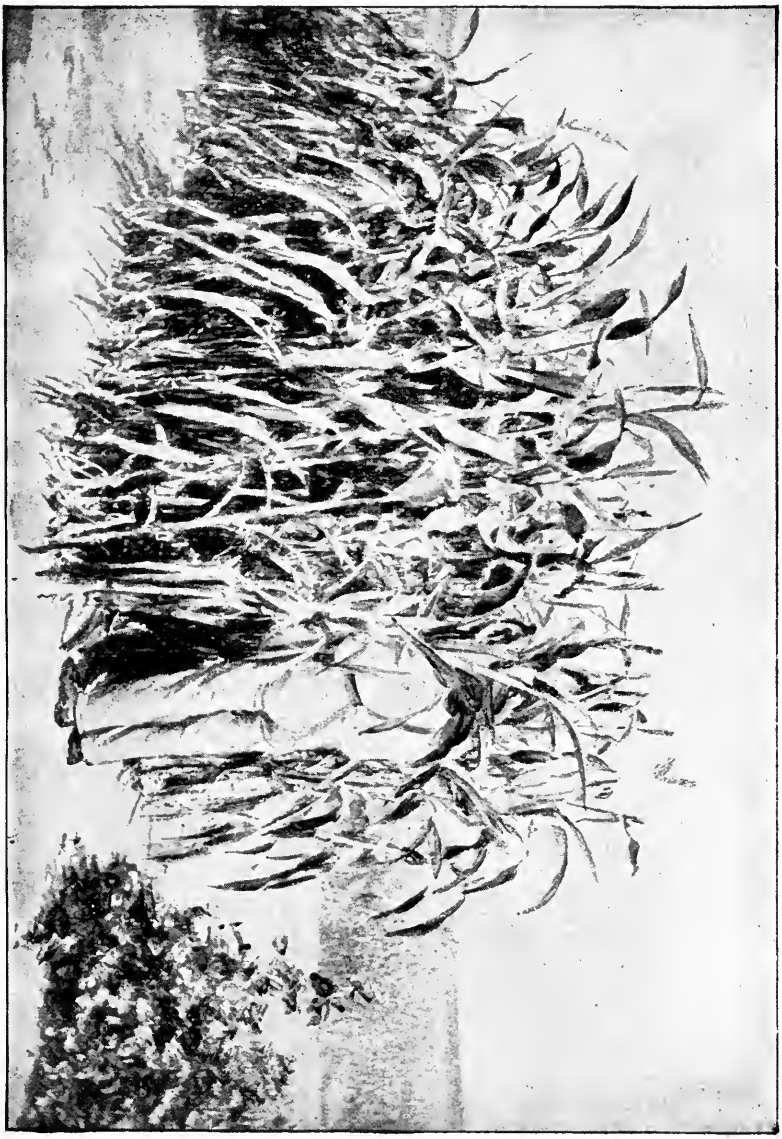

Fig. 11. White Milo Maize Grown for Fodder.
—Minnesota University Experiment Farm.

small ears. They grow numerously around every top joint, and are inclosed in a husk. Some of the heads remain erect, as those of Kaffir corn. Others, as those of Dhourra and Jerusalem corn, hang down, suspended on a goose neck curve of the seed stem. Fourth, seeds are numerous, but are much smaller than those of corn. Fifth, they require a longer period to mature seed than is required by corn, hence in the far south they may be cut from two to four times in one season to provide green food. Strong evidence is here presented of the marked adaptability of these plants to furnish pasture, but with the exception of Kaffir corn the author is unable to cite conclusive experience in growing these crops for pasture. Reasoning from general principles, teosinte should lead the list in such adaptability, because of its extraordinary tendency to tiller and to produce an abundance of fine leaves. But the question of palatability will have an important bearing on the relative value of these various plants for pasturing, and this does not as yet appear to have been fully determined.

The non-saccharine sorghums differ from one another in the following particulars among others that could be enumerated: First, in the size and strength of the stem. Second, in the size and number of the leaves. Third, in the erect or pendulous character of the stem which sustains the matured seed. Fourth, in the degree to which they sucker or tiller, and, fifth, in the time which they require to mature their seed. At the Minnesota University experiment farm in 1897, but little ripe seed was produced by any of the non-saccharine sorghums, although planted on May 17th. These plants were not seriously injured

Fig. 12. Brown Dhourra Grown for Fodder.

—Minnesota University Experiment Farm.

by frost before October. White Milo maize did not mature any seed, and teosinte did not reach even the earing stage. Several varieties of corn planted at the same time matured seed by September 1st and some even earlier; and Early Amber sorghum planted at the same date fully matured its seed.

It is not easy to draw the line between the non-saccharine sorghums and some varieties of millet. The chief differences would seem to lie in the size of the stalk, the abundance or otherwise of the leaves, the size and shape of the head, and the size of the seed. The stems of millets are smaller and more leafy, though Pearl millet has stems nearly as large as some of the sorghums. The heads of the sorghums are larger and broader and less slender in character.

Distribution.—The non-saccharine sorghums are of course specially adapted to conditions warmer and drier than are suitable for growing Indian corn at its best. They have been found preferable to the saccharine sorghums in many localities, for the reason that they give better yields of stalk and grain, and some of them are more leafy. It would not be easy or possible at the present time to state exactly where the dividing line should run between those portions of the United States which will grow corn or the non-saccharine sorghums to the best advantage. Bearing in mind that the latter require more heat and can endure more drouth, they must be grown south rather than north. The non-saccharine sorghums will probably grow more food per acre than corn south of a line as now described: This line would begin at the Atlantic and would probably run along or near the southern border of the states of Virginia and Kentucky until reaching the Mississippi

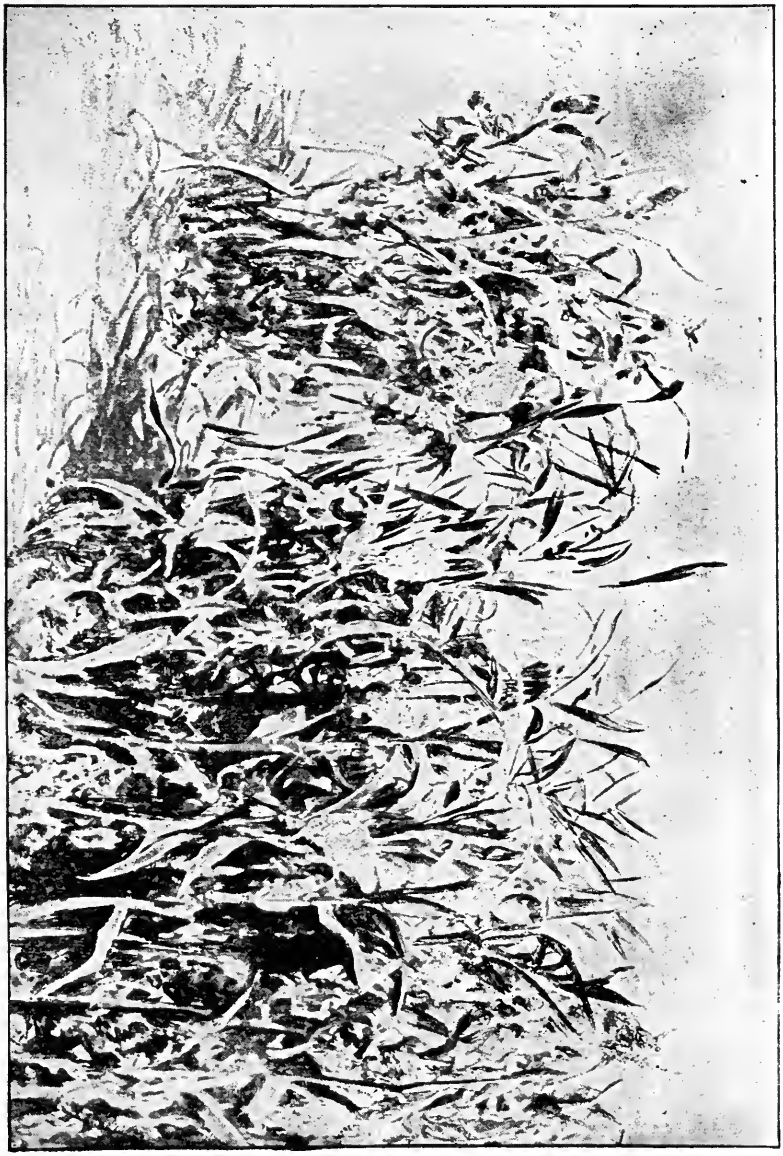

Fig. 13. Jerusalem Corn Grown for Fodder.
—Minnesota University Experiment Farm.

river. It would then run irregularly across the states of Missouri and Kansas to about the latitude of Denver in Colorado. From Denver it would probably rise to the latitude of Salt Lake City, or even further northward in the lower valleys, and it would again dip southward, reaching the sea somewhere about San Francisco. North of this line it is pretty certain that corn could be grown more profitably at the present time, for the combined uses of the product of the grain, the fodder and the pasture. But for pasture only, some of them are likely to prove more valuable than corn, although it is questionable if any of them will show a higher relative value than the saccharine sorghums in providing pasture north of the said line. Saccharine sorghums germinate more quickly, at least in some of their varieties, and are better able to endure lower temperature. But as the non-saccharine sorghums become better acclimatized, more may be expected from them. The growth of these, however, is not likely ever to prove profitable in any considerable areas of Canada, since in that country the mean summer temperatures are low.

And the expectation is natural that the non-saccharine sorghums will not grow equally well in all parts of the south. Future experimentation with them will doubtless show special adaptation to certain peculiarities of soil and climate. Already are they being grown more in certain centers than in others. Kaffir corn has given excellent results in the dry areas of Kansas and Oklahoma. Milo maize has grown excellently well in certain of the Atlantic states, notably Georgia, and teosinte is giving evidence that it is going to be a child of the far southward portion of this country.

Place in the Rotation.—When the non-saccharine sorghums are grown on soils low in fertility and leechy in character, the aim should be to grow them after some form of green crop that has been plowed under, as, for instance, crimson clover, one or the other of the vetches, or winter rye. Since crimson clover and the vetches are able to store nitrogen in the land, they will be much more suitable than rye where they will grow equally well. These crops can be grown in the winter and plowed under in the spring in ample time to admit of sowing one or the other of the non-saccharine sorghums on the same land. Thus treated they will greatly add to the ability of the soil to produce. In addition to furnishing readily available food for the sorghums, they will also give the land much power to hold moisture. Both crops, that is to say, the green crop and the sorghum crop coming after it, would be cleaning crops. Where these crops can not be made to follow a green crop plowed under, they may be placed anywhere in the rotation. On poor soils it would be necessary to add commercial fertilizers before planting the crop. But on the rich soils of the Mississippi basin this would not be so necessary, and the same is true of much of the soil in Texas and in the mountain valleys of the southwest.

Soils.—The soils most suitable for the non-saccharine sorghums are much the same as those that are best suited to corn. They will grow best on mild loams, that is to say, loams that are warm and friable, in which the particles are fine rather than coarse, and in which the sand and clay are so blended as to give the soil power to retain a fair amount of moisture when lying

on a subsoil of somewhat porous clay. But since these sorghums are all possessed of much power to gather food under dry conditions, they will grow better relatively on sandy bottoms than corn. A chief difficulty to be overcome in many of the soils of the south is a want of fertility, hence it is oftentimes necessary in some way to fertilize them in the Gulf and Atlantic states of that region, in order to get good crops. But the black soils of many of the river bottoms, of the prairies west of the Mississippi, and the gray soils of the southwestern valleys being rich in food constituents, are admirably adapted to growing these crops when sufficiently supplied with water, and without the necessity of adding fertility in the meantime.

Preparing the Soil.—When preparing the soil for these crops, much will depend on the attendant conditions. In the Gulf states, where moisture is much more abundant than in trans-Mississippi areas, the land may be plowed in the spring. Of course where a green crop grown through the winter was to be turned under, of necessity it would have to be turned under in the spring. In areas more dry, as, for instance, western Kansas and Oklahoma, it would be better to plow the land in the autumn where the same could be done, and to harrow it betimes in the spring until the season had arrived for planting the sorghum. Where irrigation is practiced, of course the farmer may plow the land at that season that will best suit his convenience and the end that he has in view.

When a green crop is turned under in the spring the land should be rolled as soon as possible thereafter to hinder surface evaporation. And where the

land will not drift, the same treatment should be given to spring plowed land in any case, in areas where moisture is not plentiful.

Where commercial fertilizers are applied, it is common to sow them at the same time as the seed. The seed and the fertilizer, however, should not be deposited by the same drill tube, lest the fertilizer should injure the seed, because of too close proximity to it and in quantities too large. When it is desired to sow the sorghums thickly, as for pasture, it would be easily practicable to apply the fertilizers in the broadcasted form and just before the drilling in of the seed. The kind of fertilizer to apply must be determined chiefly by the needs of the land.

Sowing.—Since all the non-saccharine sorghums are natives of the south, they cannot endure low temperatures. It is useless to plant them in a soil not yet warm, or before the arrival of distinctively settled warm weather. If planted sooner, either the seed will not sprout at all or it will make but a feeble and sickly growth after it has sprouted, if indeed the young plants do not perish outright. At the Minnesota University experiment station it has been noticed, first, that seed corn of varieties grown north until acclimated will sprout under conditions much more adverse than the more tender southern varieties of corn, and that the growth of the young plants will be correspondingly more vigorous. Second, that the early growth of varieties long acclimated is more vigorous than that of varieties but recently acclimated. Third, that these varieties of corn will grow with a fair amount of vigor under conditions where the seed of Early Amber sorghum with all its ruggedness would fail to germinate, or

where though able to germinate it could make only a feeble and sickly growth. Fourth, Early Amber sorghum plants made a fair amount of growth under conditions of temperature too low for the successful starting of the non-saccharine sorghums. Fifth, that among the non-saccharine sorghums, the slowest in starting was teosinte, and, sixth, that when any of these sorghums made but a feeble growth at the first, the plants from seed sown later and under more favorable conditions as to temperature made a much more satisfactory growth. There would seem to be no advantage therefore but rather disadvantage in planting the seed of the non-saccharine sorghums earlier than the season of abiding warm weather.

It would be impossible to fix the exact date at which the seed of these plants should be sown. It will vary with the locality and with the season. The date for planting would of course be later than the date best suited to planting corn. Kaffir corn should follow doubtless close upon the corn planting season, while teosinte would not suffer though not planted until a period considerably later.

To provide soiling food and also fodder, non-saccharine sorghums are usually sown in rows and at distances which vary with the soil and with the variety of the plant. Usually they should not be grown less distant than corn grown for the same uses, that is to say, the rows should not be closer than thirty inches nor more distant than forty-eight inches. But a distance of sixty inches is allowed in some instances between the rows of teosinte; and the taller of these plants, as, for instance, Milo maize, would seem to require a greater distance

between the rows than the shorter varieties, as, for instance, Jerusalem corn.

When grown for pasture the seed may be sown broadcast and covered with the harrow, but when thus sown more seed is required, as some of the plants will fail to germinate, nor will they come up so evenly, since the seed is buried at uneven depths. The subsequent use of the harrow will tear out a goodly number of plants, since at first they are less robust than corn plants, and less firmly rooted in the soil. And if grazed while the plants are still young and tender, more of them will be pulled up by the roots. It is preferable, therefore, to plant the seed with the grain drill, and with all the tubes in use; but under some conditions, as, for instance, those in which the probable rainfall is deficient, it may be advantageous to plant the seed in rows far enough apart to admit of cultivation other than harrowing.

When the seed of these sorghums is sown broadcast to provide pasture, not less than one bushel per acre of seed is required. But under conditions that are very dry, much less than that amount may suffice, since the plants if too numerous will pine for want of moisture. When planted with the grain drill with all the tubes in use, three pecks of seeds should be ample; and when the rows are made distant enough to admit of horse cultivation, a few quarts of seed per acre will be found sufficient.

Cultivation.—If sown broadcast, the only cultivation that can be given to these crops would be to harrow them, and the harrow would have to be used with extreme caution. It should of course be light, and when so used the teeth should have much of a backward slant, otherwise too many of the plants

would be torn out or buried. In any event, many of them would be disturbed or uprooted, and to provide for such a contingency it would be necessary to sow enough seed to allow for the thinning that would thus be given to the plants. If sown with the grain drill, all the tubes running, or only a part of them, the cultivation would be the same. But when thus sown there would be less disturbance to the plants, as the seed would be deposited more deeply in the soil, and if the harrowing were given just before the young plants appeared above the surface, the disturbance would be less than when given later. Since these plants are more delicate than corn when young, the harrow cannot be used upon them so freely.

When planted in rows to provide pasture, or indeed for any purpose, it would be greatly advantageous to the crop to cultivate it frequently when the rows are sufficiently distant to admit of horse cultivation. The kind of cultivation would be about the same as for corn, and the benefits therefrom would be similar in kind. (See Page 22.) After a season of depasturing such cultivation would be very beneficial, since it would take away any tendency to over-impaction or encrustation of the soil that might arise because of the treading of the hoofs of the animals that had been thus grazed.

Pasturing.—No one of the non-saccharine sorghums would seem as yet to have been grown to any considerable extent for pasture, and yet some of them at least may be made to render excellent service in that way. Kaffir corn grown at the Minnesota University experiment station proved quite satisfactory in providing summer pasture for sheep, but not quite

so much so as the Early Amber variety of sorghum. When grazed off at the hight of about a foot it at once shot up again and with a greatly increased number of shoots. The blades of the Kaffir corn were coarser and when the pasture had been grazed down they did not grow up again so erectly nor so numerously ; and yet it is possible that in localities in which there is betimes a deficiency of moisture, Kaffir corn may furnish more pasture than sorghum. Milo maize in both of its varieties should furnish excellent pasture and much of it, since it is a vigorous plant and prolific in growing leaves. But no one of these plants should prove equal to teosinte in providing pasture. When teosinte is not sown too thickly, it produces leaves in great abundance, nor has it a tendency to throw up the stems at so early a period as the other non-saccharine sorghums. But the author has not been able to glean any information based on experience with reference to the pasturing of this plant. In the far south it would prove a great boon as a pasture plant.

While these plants may under some conditions be pastured off by any class of live stock, there would probably be much waste from pasturing on them heavy animals, as horses, mules or cattle, and the more advanced the growth of the crops the greater would be the relative waste. But it would not be wise to pasture such animals upon them even at an early stage of growth, for then the plants would be so much bruised and crushed by the hoofs of the animals that many of them would be likely to perish. But there may be occasions when it would be in order to pasture these crops with heavy animals, although much waste should result, as

when, for instance, they are to be plowed under for green manure.

In providing pasture for sheep and swine, they should be equally serviceable with sorghum. Sheep especially should graze them down with but little waste, if turned in upon them before they got beyond the hight of, say, twelve inches.

In pasturing off these crops, it would be necessary to observe much caution in turning in animals to graze after the application of irrigating waters, or after much rainfall, especially on lands that are easily injured by treading when thus pastured. Impaction under these conditions would greatly injure the future growth of the crop.

The duration of the season of depasturing should be considerable in the south, owing to the length of the season. The relative advantage, therefore, from growing such crops in the south and southwest should be considerably greater than in the north. For how long a period they will provide pasture from a single sowing, the author is unable to say. Much that it would be greatly advantageous to know in regard to the growth of these plants cannot be given as yet. It can be unfolded only by the experience of the future.

CHAPTER V.

PLANTS OF THE CLOVER FAMILY.

Unfortunately the number of the species of this very useful family of forage plants that have hitherto been grown in North America is not large. The list includes the common or medium red, the mammoth, the alsike, the crimson, the white or Dutch clover and alfalfa. All of these are grown for forage to a greater or a lesser extent, and all of them are also grown singly or in certain combinations to produce fodders to be eaten in the cured form. But it is only with reference to pasture that they will be considered here.

COMMON OR MEDIUM RED CLOVER.

Common or medium red clover (*Trifolium pratense*) is one of the best forage plants that a kind Providence ever gave to the people of this continent. Its great value as a forage plant arises, first, from the length of the season during which it will provide pasture; second, from the large amount relatively of this pasture that it will furnish from a given area; third, from the high nutritive properties it possesses; fourth, from the almost uninterrupted continuity of the growth of the plants from spring until autumn; and, fifth, from the ease with which it may be grown in combination with various other forage plants. Usually, medium red clover will furnish pasture

from the commencement of the season of growth until the arrival of autumn frosts of some degree of severity. There is no other kind of clover that will furnish as much pasture in a single season. The high nutritive properties which red clover possesses are made manifest in the chemical analysis which the pasture gives, and in the quick improvement in the condition of the animals that are pastured upon it.

It is also excellent for milk production, because of its nitrogenous character. Medium red clover will grow from spring until fall, in a moist climate, without any interruption. Of course, in dry climates continuity in growth will be interrupted soon after the arrival of dry weather, in the absence of irrigation. And it may be grown for pasture with much success in combination with such plants as timothy, alsike, small white clover, and orchard grass. The weak point in common red clover as a forage plant lies in its short life as compared with some other pasture plants. Speaking in a general way, it would be called biennial, but in some sections of the republic peculiarly adapted to its growth, as, for instance, the part of Washington state that borders on Puget Sound, it assumes a perennial rather than a biennial character, and the same is true of it in many of the Rocky Mountain valleys.

Distribution.—Happily, this wonderful plant, too little valued because of its commonness, has a wide distribution. Like blue grass, it is in a sense cosmopolitan in much of the United States and Canada. But there are considerable areas, nevertheless, that are too cold, too warm or too dry for its successful growth. Among the first are the areas west

of Lake Superior, north of the 50th parallel, and east of the Rocky Mountains. Among the second are the areas that lie south of an irregular line that would probably be confined within the states lying between the 35th and 40th parallels. And among the third are the areas that lie in the upper Missouri basin and southward therefrom. But in each instance there are exceptions to the limits thus put upon the growth of medium red clover, for its successful production depends even more upon altitude than upon parallels of latitude and longitude.

Place in the Rotation.—Medium red clover may be given any place in the rotation. But it is peculiarly fitting that it shall be sown after a crop that has been cultivated with a view to cleaning the soil. When grown for pasture, however, it is not so necessary that it shall be sown on clean land as when grown for other uses, since timely depasturing will prevent nearly all forms of weed life from ripening their seeds in the pasture. And it is good practice to follow it with some kind of crop that requires much nitrogen to grow it in good form, since, as is now generally known, clover has much power to take nitrogen from the air and place it in the soil. The roots of the plants that immediately follow the clover may readily appropriate it. The small grains, corn and sorghum, may, with much advantage, be made to follow clover.

Soil.—Clay loam soils that lie upon a subsoil of what may be termed mild clay are usually considered the best for the production of clover. But to this there may be some exceptions. Stiff clay, with a subsoil not too unyielding, will produce good crops of clover when sufficient moisture is present, particu-

larly those of a reddish cast, as, for instance, the clay lands lying southward from Duluth, Minn. The same is true of some sandy soils, more especially those of volcanic origin, as, for instance, soils in the Flathead valley, Mont. The light soils of the prairie, that sink readily beneath the tread when being cultivated, do not possess marked adaptation for the growth of clover; but it can be successfully grown on these when moisture is present in sufficient quantities, and where the climate is otherwise suitable. Over large areas where clover could not be made to grow successfully on these soils when first brought under cultivation, it now grows with much certainty as a pasture crop and also as a hay crop. This is partly owing to the firming of the land through cropping it, and partly, it is claimed, to the increase of certain bacteria in the soil favorable to the growth of clover. These, it is affirmed, increase in the soil with the continued growth of the clover. Although clover will grow on land that is not rich, it may be necessary to enrich some kinds of poor soil, as, for instance, poor sands, before clover can be made to grow on them with any marked degree of success. The attempt to grow clover successfully on such lands when the rainfall is not plentiful, and when they are underlaid with sand and gravel, is a hopeless undertaking in the absence of irrigating waters.

Preparing the Soil.—In growing clover for pasture, the preparation of the soil is the same as in growing it for hay. It is more commonly sown along with a nurse crop, hence the preparation of soil that is best suited to growing the nurse crop will also usually be best suited to the growing of the

clover. With soils that are naturally of a stiff texture, the aim should be to secure a deep and fine pulverization in the seed bed. Such are the clays of Ohio and of some states further east; and also those of Ontario and other provinces east from Ontario. With soils that are of a spongy character, and especially with those that lift more or less with the wind, the aim should be to firm the seed bed when preparing it. Such are certain of the soils covering a considerable proportion of the upper Mississippi basin and its tributaries. Soils that are liable to be surcharged with water during any considerable portion of the year will prove much more suitable if drained before being laid down to clover. In some instances surface drains will suffice, but in others underdrains will be more suitable.

Sowing.—The early spring will, in nearly all instances, be found the best time in which to sow clover. But there may be localities abundantly supplied with moisture and favored with mild winters in which it would be practicable to sow clover during the late summer and early autumn months. This should not be attempted, however, in any locality in which the winter temperatures are low. And while there may be sections subject to severe frosts after growth has begun in the spring, in which it may be wise to defer sowing clover for a time after the ground is ready to receive it, as a rule clover should be sown as early as practicable in the spring.

As has been stated, clover is usually sown with a nurse crop. A nurse crop is one that provides it with shade when it is young. Winter wheat, winter rye and barley are very suitable as nurse crops for

clover, since the shade they furnish is less dense than that of some other crops; and the shade is sooner removed, as they are harvested early. The two first named cereals also admit of early sowing. Spring wheat and oats shade the seed overmuch, but of the two spring wheat is more suitable than oats as a nurse crop. Flax does not provide a dense shade, hence it would sometimes answer well as a nurse crop but for the reason that the later season at which it is sown makes a "catch" of the seed more hazardous to obtain.

Some authorities advocate sowing clover alone; that is to say, sowing it as the sole crop on the land. There may be some instances where it may be wise to adopt this plan, more especially where it is difficult to get a stand of clover because of the dearth of moisture. It is at least questionable if this method of sowing clover will ever be very generally practiced, and for the following reasons: First, it is not necessary in moist climates; second, the growth of weeds is apt to crowd the clover plants more than a nurse crop of grain would; and, third, on some soils, especially stiff clays, the shade furnished by the nurse crop when young is advantageous to the clover plants while in the early stage of growth. It would seem to be a better way where there is a fight for moisture between the nurse crop and the clover, to sow the clover along with oats, using not more than half the usual quantity of the seed of the oats per acre. Oats are mentioned because of the use that can be made of them for hay when they are harvested. They should be harvested as soon as the heads are fully out, and sometimes even earlier, that more moisture may be left for the clover, and that

more sunlight may shine upon it to make the plants strong. But if the season should prove moist, the oats may be allowed to stand until they have matured.

At the Central Minnesota experiment station the author has had much success in getting a catch of clover seed, and also of timothy seed, by sowing these along with a mixed crop of peas and oats, grown to provide summer forage for sheep. The soil is a sandy loam, light enough in texture to wash easily. The clover seed was sown broadcast at the same time as the peas and oats, and covered with the harrow. The system of depasturing will be described in Chapter VIII. And it is probable that such a method of obtaining a stand of clover will be found even better adapted to the dark, spongy soils of the prairie, whether the clover is sown along with peas and oats, other cereals, or rape, and whether the pastures thus furnished are grazed down by cattle, sheep or swine. The reasons for this belief are logical. The tramping of the ground firms the soil, and so lessens the escape of moisture by evaporation; and the removal of the nurse crop by depasturing leaves more moisture for the clover than would be left to it if the crop were not grazed down, and also lets in sunlight to strengthen the crop.

Clover seed may be sown broadcast by hand, with any form of hand seeder that has been found suitable, or with an attachment to the grain drill. It is sometimes mixed with the seed grain and is sown along with it, but this method of sowing is not to be commended. The clover, being the smaller seed, runs out more quickly than the grain, hence the "seeding" is irregular. More commonly it is con-

sidered preferable to have the grain fall before the tubes of the grain drill, that the seed may thus be provided with a covering.

Whether the harrow or the roller, or both, shall be used in covering the seed is a question entirely dependent on conditions. On prairie soils and in localities where dry weather is prone to come early in the season, the seed should be covered deeply, but on clay soils it should be covered less deeply. When sown on lands which carry a crop of winter wheat or winter rye, the harrow should always be used to cover the seed if the soil has dried enough to admit of so doing. When the seed drops before the drill tubes, with clay soils the covering furnished by the grain tubes which follow will be ample, but on loose or light soils it may still be necessary to follow the drill with the harrow. And in a dry seed time great good would almost certainly result from following the seed drill with the roller, and the roller with the harrow. The roller would impact the land and the harrow would lessen the tendency to evaporation in the soil, and also the tendency to be lifted by the winds. In the states and provinces east of the upper Mississippi basin, when clover is broadcasted on land that has been sown with some spring cereal the roller alone will provide an ample covering for the clover seed.

Cultivation.—Medium red clover does not, of course, require any cultivation after it has been sown. But there may be instances in which the harrow may be used as an aid to the re-seeding of pasture lands, when it is not considered desirable to plow them up. If the clover on these has not been cropped too closely many clover heads will

mature their seeds. These in due time will fall to the ground. The following spring the harrow may be made to render good service by running it over these lands as early as possible. It helps to bury the seed, and as the seed remains in the seed sacs, it is almost certain to grow. The harrowing may also be done so late in the fall that the seed will not sprout previously to the coming of the winter. The benefit from this form of re-seeding will be dependent upon such conditions as relate to soil and climate. Much of the soil of the prairie seems to be adapted to this form of re-seeding. There are localities in which it is possible to maintain a clover pasture for years by the adoption of this method.

Pasturing.—Common or medium red clover should not be pastured off ordinarily the same year it was sown. Such pasturing removes the covering that would otherwise protect the roots of the clover in winter. And if done early in the season it would also hinder root development. But there may be instances in which the growth of the clover would be so luxuriant that it would be proper to pasture it off to prevent smothering in the winter, especially in localities where a heavy snowfall may be expected.

The second season after sowing the clover is that in which it provides an abundance of pasture. In grazing live stock upon it the aim should be to keep it so cropped off that it will not become rank and coarse, otherwise much of it is liable to be trodden down rather than eaten off. If the clover should grow so rapidly as to get ahead of the needs of the stock, the mower should be run over the field not later than the blossoming stage of the clover. The clover so cut may remain on the field as a

mulch, or it may be cured for hay, as desired. Swine pastures especially will be benefited by this mode of treatment, and in any event it will hinder the maturing of weed seeds.

There is no better method of obtaining a crop of medium red clover seed than by pasturing the clover closely for a time, and then removing the stock. The pasturing should begin as soon as the growth in the clover plants will warrant turning in the stock. The season for removing the stock will vary with the locality and with the rainfall, but in any event it should take place from, say, ten to fifteen days earlier than the period when the clover not so pastured would be in bloom. Clover plants thus managed seem capable of bearing more and better seed than those which come into flower before they are cut to be made into hay. After the seed has been removed, another season of pasturing may follow, but the production of seed lessens the power of the plants to grow pasture.

After the first cutting of the clover has been made in order to provide hay, an abundance of pasture will usually be furnished by the clover the same season, providing a crop of seed or a second crop of hay is not desired. As the weather at that season is usually drier than in the spring, the live stock should not be turned in on the clover until it has made considerable growth, as then it furnishes more or less shade, which tends to lessen evaporation.

Medium red clover furnishes excellent pasture for horses, cattle, sheep and swine. But sometimes there is hazard in turning cattle and sheep into a clover pasture, more especially when the plants are very succulent, and the hazard is increased when

they are wet with dew or rain. If the cattle or sheep are hungry they will eat so freely of the clover that hoven or bloating may follow. Unless treatment is promptly given they are pretty certain to die. The treatment suitable is given on Page 162, Observation 4.

Observations.—1. The common or medium red clover is not specially adapted for being grown in permanent pastures because of its short-lived habit of growth. It may be well to sow it in these, but only in limited quantities and with the expectation that it will nearly all disappear at the end of two or three years.

2. When medium clover is to be sown on clay lands or black loam soils, where it is liable to "lift" or "heave" with the frost in the spring, such heaving or lifting may be avoided in a very considerable degree by first draining the lands. The heaving is caused by the alternate freezing and thawing of the lands that are surcharged with moisture.

3. Much fall pasture may be furnished in localities that are favored with an ample supply of rainfall by sowing medium clover with all the cereal crops grown, even though the land is to be plowed again in the late autumn or in the spring following. Much pasture may thus be obtained, especially in "dropping" or showery seasons, to say nothing of the plant food put into the land. But what is termed "heavy seeding" should not be resorted to, lest a period of dry weather should follow, when the seed would be lost. Less than half the usual quantity sown would be enough to risk thus.

4. In seasons where clover is usually grown in short rotations and where seed crops are frequently

harvested from it, much seed becomes stored in the land. A portion of what is thus lodged in the soil is brought near the surface by the ordinary processes of cultivation, and in due time it grows. The clover, as it were, "seeds" itself, and it thus furnishes much autumn pasture without any cost to the grower.

MAMMOTH CLOVER.

Mammoth clover (*Trifolium medium*), as the name would indicate, makes a strong and vigorous growth on soils possessed of the requisite adaptation. Like the common red clover, it is a biennial, although to this habit of growth there are some exceptions. On soils with a marked adaptation for growing mammoth clover it will live longer than in those opposite in character. The same result will follow if the climatic conditions are just right. And if hindered from producing seed, as, for instance, when it is pastured, its life period will be prolonged. It resembles the common red in the form of the leaves, the shape and color of the blossoms, and in the general habit of its growth as to form in top and root. And it differs from the same—first, in the greater size of the stems and heads; second, in the greater hight to which it grows; third, in the later season at which it matures; fourth, in the greater size of the roots and in the greater depth to which they penetrate; and, fifth, in its inability to produce two crops of hay in one season, or to provide an abundance of pasture after the usual season for seed production. It is evident, therefore, that mammoth clover is not so well adapted to provide pasture as the medium red; but there is a place for it, and

that place will be found, in many instances at least, on soils where medium red clover will grow but not with marked vigor. The mammoth being a stronger plant, it has more power to gather plant food in the soil.

Distribution.—The distribution of mammoth clover is much the same as the distribution of the medium red variety. (See Page 68.) Where the one will grow so will the other, at least measurably well. So far as the two varieties have been tried this result has been noticed. The mammoth clover, however, has not yet been grown over so wide an area as the medium red, hence it is possible that there may be localities where one of these varieties only will flourish, but if so these have not hitherto been defined.

Place in the Rotation.—Mammoth clover should be given the same place in the rotation as the medium red clover. (See Page 69.) It should be sown for pasture, therefore, in short rotations, and should follow, when practicable, a cultivated crop, to be succeeded by a grain crop.

Soil.—The soils suited to mammoth clover are substantially the same as those suited to the medium red variety. (See Page 69.) Since mammoth clover, however, would seem to have greater power to gather plant food in the soil than the medium red, it is relatively better adapted to lands not well supplied with fertility. And as it sends its roots deeper into the soil, it is better able to withstand drouth in dry seasons, and also the influences that cause heaving or lifting in dry soils supplied with too much moisture in the season of freezing and thawing. Mammoth clover, therefore, has, in some

instances, found more favor in the sandy soils and even in the loam soils of the prairies that border on the semi-arid region east of the Rocky mountains.

Preparing the Soil.—Preparing the soil for mammoth clover is substantially the same as preparing it for the medium red variety. (See Page 70.) But it is even more important with mammoth clover to have the ground deeply plowed previous to the growing of the cultivated or other crop that precedes the clover, that its roots may readily push down into the soil. This is not inconsistent with firming spongy soils subsequent to the deep plowing.

Sowing.—The various methods given as suitable for sowing red clover are the same as those that should be adopted in sowing mammoth clover. (See Page 71.) The amount of seed required to provide pasture will depend upon the fact as to whether it is to be sown alone or in combination with other kinds of pasture plants. When sown alone not less, probably, than ten pounds of seed per acre should be used, as the seed is somewhat larger than that of the medium clover. And when the conditions are not all favorable, it would be good practice to sow a larger quantity of seed. When sown with the seeds of other pasture plants, the quantity of seed used should be proportionately reduced. More pasture will be furnished where mammoth clover is sown along with medium red clover, as the latter grows vigorously in the spring and in the autumn, and the former is at its best in the late spring and early summer. When thus grown, equal parts of the seed of each variety may be used.

Cultivation.—As with medium red clover, no cultivation is required. (See Page 74.) What is said of medium clover under the head of cultivation will apply equally to the mammoth variety.

Pasturing.—Much of what has been stated in regard to the pasturing of medium red clover will apply with equal propriety to the pasturing of mammoth clover. (See Page 75.) Like medium clover, it will furnish pasture well adapted to the needs of all kinds of live stock grown upon the farm. Animals may be turned in on it as soon in the spring as it will furnish them plentifully with food. It is even more important not to let the clover get beyond the power of the animals to crop it back than when pasturing the medium variety. And it is equally important that cattle and sheep shall not be allowed to pasture upon it at will while hungry, more especially when it is wet from dew or rain. It will not furnish much pasture in the autumn, whether it has been grazed during the season previously or cut for hay.

When the clover is to be cut for seed, it may sometimes prove an excellent plan to graze it off closely for a time in the early spring, lest the energies of the plants become too much concerned in the production of a superabundant growth of stems and leaves. On soils pre-eminently adapted to the growth of clover this precaution should not be neglected.

While the pasturing should be close, it should not be long continued, or the development of the plants may not be sufficient to produce a maximum crop of seed. This result is certain to follow prolonged pasturing if the weather should turn dry. It

is better, therefore, to run some hazard from over vigor in the growth of the plants than from insufficient development, since the loss is likely to be less. On some soils it may not be necessary to pasture thus to any extent.

Observations.—1. Mammoth clover is not well adapted for permanent pastures, since it is not usually perennial in its habit of growth. Nevertheless, it may be sown as a part of the mixture with the expectation that it will live for two years and possibly for a longer period.

2. This clover makes an excellent fertilizer to plow under, because of the great bulk of the green product that it furnishes, and because of the great mass of vegetable matter in the root growth. When grown for this purpose, it may be advantageous sometimes to let it grow up until near the blossoming stage and then to pasture off the more palatable portions previous to plowing under the residue.

ALSIKE CLOVER.

Alsike clover (*Trifolium hybridum*) is distinguished from the common red or medium clover, first, by the finer and more recumbent character of the growth; second, by the later season at which it matures; third, by its inability to produce much pasture after the season of maturity; fourth, by the pinkish rather than the blood red tinge which characterizes its blossoms; fifth, by the much less size of the roots; and, sixth, by its perennial rather than biennial habit of growth. The roots do not go down so deeply into the soil, hence it has less power to withstand prolonged drouth on the uplands. It

is much superior to the common red in providing honey for bees, and it is also better adapted for being grown along with timothy, first, because it ripens at the same time; and, second, because ordinarily it crowds the timothy less than the common red. It can withstand lower temperatures than the common red, hence the limit of its growth is further north than that of the other. And when supplied with moisture it would seem to be adapted to temperatures equally warm. It can usually be grown in good form between the 40th and 50th parallels of north latitude, from the Atlantic to the Pacific, when sown on soils with the requisite adaptation; and south of the 40th parallel it can also be profitably grown under certain conditions.

Place in the Rotation.—Alsike clover, like the medium red, should be sown on soils that have been previously cropped with grain, and to such an extent that they require an increase of nitrogen and of vegetable matter. The clover roots will supply both of these. If the crop immediately preceding the clover has been a cultivated crop, and if it has been suitably cared for, the soil will be in a condition to grow the clover without any injurious admixture of weeds. Cereal crops, or corn should follow the clover. Alsike clover is not a good rotation crop, because of its perennial habit of growth. Whenever a stand has been secured it is usual to pasture it, or to cut it for hay for several years.

Soils.—Alsike clover has special adaptation for clay soils, for clay loam soils, and for the soils of the bottom lands of the Rocky mountain region that lies within the clover belt. It thrives well on the stiffest clays. It thrives better on loam soils well supplied

with humus and underlaid with clay; and, judging by the tests that have been made, it would seem to thrive best on the deposit soils of the Rocky mountain basins. But moisture must be present in goodly supply before it can grow well on any soil. The slough lands of the prairie regions would seem to have special adaptation for Alsike clover when water is not present in too plentiful supply. On such soils it may be submerged for days at a time without injury in the early springtime, but the waters that cover it must, of course, be quite shallow. It will not grow well on sandy or gravelly soils, poorly supplied with the elements of fertility. The clay loam soils of the Puget Sound country, with the abundance of moisture which they possess, furnish a perfect paradise for Alsike clover.

Preparation of the Soil.—The preparation of the soil for Alsike clover is essentially the same as for medium clover. (See Page 70.) And there are localities where this clover can be sown on newly cleared lands without any other preparation than that of removing the timber in whole or in part that grew upon them. Of course, if the fire has been made to consume a part of the waste timber, or all of it, the "catch" of the seed will be more satisfactory. Even harrowing may not be necessary. Such are the timber lands west of the Cascade mountains. Some grasses, as blue grass, for instance, should be sown along with the clover. The small white clover will soon come, as it were, spontaneously on such lands.

Sowing.—Nearly all that has been said with reference to the sowing of medium red clover will also apply to the sowing of Alsike clover. (See Page

71.) The aim should be, however, to cover the seed of the Alsike less deeply, since it is a much smaller seed. The proper depth will, of course, depend upon conditions. In moist New England, in some states further west, in eastern Canada and in the Puget Sound district, the tubes of the grain drill as they deposit the nurse crop will sufficiently cover the seed that has been dropped or scattered before the drill. In the absence of a grain drill the roller will provide a sufficient covering. But in the prairie soils of the upper Mississippi basin a light harrow will not cover the seed too deeply.

To provide pasture, Alsike clover is more commonly sown along with some other kind of grass or clover, as, for instance, timothy, orchard grass, Kentucky blue grass, and medium red clover. But it may also be sown alone. Wherever orchard grass will flourish, Alsike clover and blue grass make an excellent combination along with it in providing pasture, since the two grasses grow both early and late in the season, and the clover is at its best in the early summer. On the slough soils of the prairie, Alsike clover, timothy, and blue grass or red top make a good pasture.

The amount of seed required will be dependent chiefly on the grasses along with which the clover is sown. If sown alone, four pounds of seed per acre will be found sufficient in nearly all soils. If sown along with other grasses, the quantity must needs be proportionately decreased.

Cultivation.—Alsike clover, like the other kinds, does not require to be cultivated. But on suitable soils it may be made to re-seed itself, and thus to retain its hold upon the ground for many

years. The method by which this end may be accomplished is substantially the same as that given for securing the re-seeding of the medium red clover. (See Page 74.) But with Alsike clover this end is more easily attained than with the common red, since heads of matured seed uneaten by the live stock are apt to be more numerous because of the more recumbent character of the growth of the clover. It is also a hardier plant. However, on some soils, particularly those of a stiff character, it would not be wise thus to perpetuate clover pastures.

Pasturing.—When Alsike clover is sown alone, it may be pastured continuously after it has made a good start in the spring. But it will not produce much growth after the season for maturing the seed; that is to say, after the period about simultaneous with the ripening of the barley crop. Because of this habit of growth the value of Alsike clover as a pasture crop is materially decreased. As with other kinds of clover, more pasture will be obtained where the cropping is not too close. When the pasture is grazed too closely, the hot sun produces a more rapid evaporation on the unshaded ground, and it further weakens the chance of the plants to grow because of cramped breathing capacity. Close cropping in the autumn increases the hazard to the plants from cold winds and severe frosts, since it completely removes the covering that would otherwise aid in protecting them.

Alsike clover pasture is relished by all kinds of live stock grown upon the farm; and there would seem to be less danger of hoven when animals are feeding upon it than when feeding upon medium red

or mammoth clover pastures. This point, however, has not been unequivocally established.

When Alsike clover is wanted for seed. it may be advantageous to pasture it for a time after it has begun to grow in the spring. The pasturing should be close as long as it is continued, to secure uniformity in the subsequent development of the crop. Such pasturing will prevent overluxuriance in the growth of the clover on soils and in seasons when such overgrowth is to be feared. The energies of the plant are thus diverted from the overproduction of stems and leaves to the production of seed.

The duration of the pasturing given to these seed crops cannot be stated, as it will vary with the character of the season. On some soils, as, for instance, stiff clays, pasturing is not required, and in any event the pasturing should not be long continued, lest it should prevent the plants from making growth enough to produce seed plentifully.

Observations.—1. Alsike clover is well suited for being sown with mixtures of grass seeds used in making permanent pastures, because of its hardihood and because of its perennial habit of growth.

2. A stand of Alsike clover may not infrequently be obtained in slough lands of the prairie by scattering the seed on the native sod in the early spring. If the native grass can be cut early or pastured off after the young clover plants have made a good start, the clover will be much benefited. But in dry summers a stand of the clover is not likely to be secured.

3. Alsike clover and timothy are well adapted

for being grown together, whether for hay or for pasture, since both grow well on humus soils

CRIMSON CLOVER.

Crimson or scarlet clover (*Trifolium incarnatum*) is so called from the beautiful rich bloom of the heads when in flower. It is said to be a native of Central and Southern Europe. Until quite recently it has not been tested in many of the states of the Union, hence its precise value as a forage crop in localities where it has not been proved cannot be stated.

Crimson clover is an annual, but has a semi-biennial habit of growth, since it is sown in the summer and matures its seeds in the springtime of the following year. It is more upright in its habit of growth than some of the other clovers, and it has probably a less proportion of leaf growth to the stems. It grows from twelve to thirty inches high, according to conditions, and reaches maturity in time to be followed with divers other crops, as corn, sorghum, and various garden vegetables. The blossoms are cone-shaped, with much of length in proportion to the diameter, and the bloom is of the richest crimson or scarlet. A field in the meridian of blossoming is a beautiful sight.

Distribution.—As stated previously, crimson clover has not been fully tested in some of the states of the Union, hence it is impossible in the present state of our knowledge to speak with sufficient definiteness as to where it can or cannot be profitably grown as a pasture crop, or indeed for any purpose. And the difficulty is increased by the contradictory

character of the reports that have been published in regard to it from the same localities. Some of these refer to it as a total failure, and others speak of it as an encouraging success. These contradictory reports arise, doubtless, from variations in the seasons and in the mode of growing it.

Speaking in a general way, the growth of crimson clover is attended with more or less of hazard north of 40 degrees; that is to say, north of the cities of Philadelphia, Columbus and Denver, and east of the Rocky mountains. Nevertheless, there are some exceptions. In Delaware, for instance, it is a success. In some parts of Pennsylvania and New York it has proved satisfactory; and in portions of other states north of the line named it has been grown with success. But within the limits mentioned there will be more or less of hazard in growing crimson clover, according as the winter is propitious or otherwise. In experiments conducted by direction of the author at the Ontario experiment station, at Guelph, the clover failed to pass through the winter alive. Unless, therefore, the habit of growth can be so changed that the plant will successfully fulfill its mission in one season, it is not likely to prove a treasure to very much of the area that has been set down as doubtful or prohibitory.

Of course, in the bench lands between the Rocky mountain ranges, and in the river bottoms, crimson clover is not likely to prove a success, unless when grown under irrigation, and reports from growing it thus do not as yet seem to be forthcoming. On the Pacific slopes of Oregon and Washington and of British Columbia it will doubtless grow, though but little tried hitherto. It should be

capable of furnishing early pasture in the spring time in that region of mild winters.

Crimson clover can be grown with success in much of the area south of the 40th parallel, and east of a line running irregularly down through the states of Missouri, Arkansas and Louisiana, and not far from the western border of these states. In other words, crimson clover would seem to have the least adaptation for those states and provinces that are far enough north to grow the medium red clover at its best. And it would seem to have the highest adaptation to localities with weather too warm to grow that species of clover at its best.

Place in the Rotation.—In the rotation crimson clover should be grown as a catch crop; that is to say, it should follow some crop that has been harvested one season, and should precede some crop to be grown immediately after the clover the following season. The plan of growing it on land that needs to be enriched is a wise one, hence it will frequently be sown after a grain crop, and before some cultivated crop that does not of necessity require to be planted early the following season. Crimson clover is, therefore, commonly grown without missing a crop. Not infrequently it is sown annually in orchards that are in bearing, and plowed under to feed the fruit trees from year to year.

Soil.—Crimson clover grows best on a warm soil; that is to say, on a soil of open texture and with good drainage. It has special adaptation, therefore, to loam soils with a free admixture of sand in them. But if the clover is to grow vigorously on these soils it is necessary, first, that moisture shall be present in the growing season; and, second, that sufficient fer-

tility shall be present in the soil or supplied to it to give the clover a good start. The average prairie soils do not seem to furnish the proper food constituents, and in stiff clay soils the roots of the clover cannot gather food with sufficient haste.

Preparing the Soil.—In preparing the soil for crimson clover much will depend upon the conditions. When sown amid corn or cotton the cultivation given to these crops is a sufficient preparation of the soil. After potatoes and early market garden crops, cultivating and then harrowing the ground should put it in good condition to receive the seed. When sown after grain, success has followed simply harrowing the land, and in other instances first cultivating and then harrowing it; but more commonly there is hazard in sowing it thus. In orchards in full bearing the cultivation that is usually given to the trees is a sufficient preparation. In preparing the soil the aim should be to secure a fine and moist seed bed, hence when the land is plowed in making it ready for crimson clover, a free use should be made of the roller and harrow, unless peculiar conditions, as excessive rainfall, should render this work unnecessary.

Sowing.—Crimson clover seed is more generally sown from July 1st to October 1st, according to the locality. Ordinarily the more southerly the latitude the later may the seed be sown without the hazard of being winterkilled. If sown in the early spring the growth made is seldom satisfactory, and the presence of the clover hinders the growing of another crop the same season. The seed is sown by the same methods as other kinds of clover seed; that is to say, it may be broadcasted by hand or otherwise and covered with the harrow, or it may be sown

with a grain drill that will properly do such work, or it may be dropped with the grass seeder attachment to the grain drill, as, for instance, when it is sown with a nurse crop.

Ordinarily the seed of crimson clover is not sown with a nurse crop, but sometimes it is sown with cowpeas. When thus sown the soil is more commonly infertile, and the peas are grown to protect the clover plants in the winter after the frost has killed the cowpeas. When sown with winter oats or winter rye the clover is prone to crowd these crops, as it continues to grow in weather too cool to admit of growth in the oats or the rye. On some soils these results will be reversed. But judicious pasturing should prevent injury from this source. When rape is sown with the crimson clover it should be early in the season rather than late, so that both plants would have time to make a good growth and thus furnish fall pasture; and if the rape survived the winter the two plants could be pastured again in the spring.

The amount of seed to sow will vary with several conditions. When sown as the sole crop, more than fifteen pounds per acre of the clover seed should not be required, and usually less than that amount will suffice. Heavy seeding is to be preferred when the clover is to be plowed under as a fertilizer. When sown as part of a mixed crop to provide pasture, a few pounds of the clover seed per acre will suffice. The grower can best learn by his own or by his neighbor's experience how to adapt the quantities of the respective seeds used to the soil conditions.

Cultivation. — No cultivation is ordinarily required on crimson clover. But there may be

instances when the harrow can be used upon it with advantage.

Pasturing.—Although crimson clover has been grown more as a fertilizer than to provide pasture, its mission in furnishing pasture and also soiling food is an important one. When the strength of the clover growing alone or in combination with other crops will justify so doing, it should of course be pastured, but not so closely as to endanger its passing the winter safely. Any kind of domestic animals upon the farm may be grazed upon it. It furnishes pasture early in the spring and in bountiful supply. Sheep have been pastured on it early in the season, and after they were removed a good crop of seed has been reaped. Such pasturing is favorable to seed production when the crop is likely to be too rank. It may also be pastured with much advantage by sheep or swine when it is grown in orchards. The fertility produced by the crop will all be returned to the land when it is thus pastured.

Observations.—1. After a crop of seed has been harvested, another crop of clover can be obtained in some instances by simply harrowing or otherwise stirring the soil.

2. When sheep or swine are used in pasturing an orchard, the trees may be protected from injury by inclosing the trunks in wire netting. To hinder the sheep, however, from eating the fruit on the lower limbs that droop is practically impossible.

ALFALFA OR LUCERN.

Alfalfa or Lucern *(Medicago sativa)* is a wonderful food plant. No other plant grown in the

United States or Canada will furnish so much valuable food for so long a term of years without re-seeding. There are some alfalfa fields on this continent that have produced several good crops a year for more than forty years, and, judging by the indications, they will continue to do so for many years longer. But those fields have been irrigated from year to year. However, there are instances on record wherein alfalfa has produced good crops for a long term of years when not irrigated. It is not so valuable relatively in providing pasture as forage, although with judicious management it can also be turned to good account in furnishing pasture, at least under some conditions.

Alfalfa is of course a perennial. It grows up rapidly in the early spring, and when the plants attain a hight of one to two feet or more, they produce bluish purple flowers. As soon as the plants reach the blossoming stage the stems rapidly become woody, hence it is necessary to use much promptness in cutting the crop for hay, or in pasturing it off in the early part of the season. When cut or eaten down, other stems come out from the basil root and more numerously, until the plants reach full size, which they do in three or four years. These stems grow very rapidly, hence the number of crops that may be reaped in one season is sometimes as high as six to eight. It sends a taproot down to a considerable depth into the soil. Under very favorable conditions this taproot is ten to twelve feet long, but usually it does not go down much beyond half that distance. This accounts for the great ability of the plant to withstand dry weather when once it has firmly intrenched itself in the soil.

The idea that it will not be worth while to grow alfalfa where medium red clover is at its best would seem to be of the fogy order, although it has been promulgated by some good authorities. As a rotation plant it is not to be compared with clover, but even where medium clover has proved a great success, there may be good reasons for growing alfalfa to provide soiling food and also pasture.

Distribution.—Alfalfa can be grown with more or less success in every state of the Union, and in a number of the provinces of Canada. But it has especial adaptation for those states where the temperatures are too warm and the conditions are too dry to grow clover at its best. Speaking in a general way, the highest adaptation for alfalfa culture is found in those states that lie south of the Missouri river, including the lands drained by that river, and west from the Mississippi where it is joined by the Missouri. Next to these states in adaptation may be placed those areas that lie south of the Ohio and between the Mississippi and the Atlantic. And after these in adaptation come various localities in the other states where the measure of success attained in growing the crop is usually more dependent on soil conditions than on those which relate to climate. There is probably no state in the Union in which alfalfa may not be successfully grown. In Louisiana it has been made to provide green food every day in the year. As far north as Toronto, in Ontario, and Montreal, in Quebec, good crops of alfalfa have been grown. But in the northern portions of North Dakota, Minnesota, Wisconsin and Michigan, the low winter temperature will probably prove a barrier to its cultivation. Elsewhere in the United

States it will endure the winters as far north as the Canadian boundary. It is not likely to succeed in the Canadian provinces that lie between Lake Superior and the Rocky mountains, but on the Pacific slopes of British Columbia there should be no difficulty in growing it when the soils are suitable.

Place in the Rotation.—As alfalfa is usually sown with the intention of allowing it to remain undisturbed by the plow for several years, it will be readily apparent that it is not a good rotation crop. In fact, it can only be used in very long rotations when thus grown. But as it is sometimes sown to provide hay and pasture along with medium, mammoth, or alsike clover, it may be used in rotations of limited duration, in conjunction with one or more of these plants. When thus grown the rotation may be the same as that adopted in growing these clovers; that is to say, it may, with much propriety, follow a cultivated crop in order to obtain a clean seed bed on which to sow it. And it ought to be followed by some crop that wants much nitrogen to perfect it, as corn or one of the cereals. As alfalfa is a somewhat delicate plant the first year, it is important that it shall be sown on clean ground where the weeds will not be likely to smother it.

Soil.—The soil best suited to the growth of alfalfa will be measurably dependent on the moisture that can be furnished to it in the form of rain, through surface irrigation or from a subterranean source. Loose, sandy loam soils rich in certain elements of plant food, particularly lime, phosphoric acid and potash, are usually regarded as the most suitable for alfalfa. These soils should be deep in character and should lie on sandy or gravelly sub-

soils, that is to say, subsoils which consist of fine gravel intermixed with sand. Such soils are eminently adapted for growing alfalfa when water is plentifully supplied from the clouds, from irrigating ditches, or from the water table in the subsoil. This water table must not be too near the surface, or the root growth will be hindered to the great injury of the plants; nor must it be too far from the surface, or it will fail to reach the plants in sufficient quantity. When water cannot be supplied from ditches or from a subterranean source, and when the summer climate is dry in character, it will be found that alfalfa will grow best in soils that are underlaid with mild, porous clay subsoils, which the roots can easily penetrate. If grown under those conditions, if the subsoil were sand or gravel, the plants would not obtain sufficient moisture. The best soils probably in the United States for growing alfalfa when amply supplied with water are the volcanic ash soils, alluvial in character, that are found in the valleys west and southwest of the Missouri river. The sandy soils of the states south and southeast of the Ohio are not usually rich enough to produce maximum crops without being fertilized. The soils of the upper Mississippi basin, with exceptions somewhat numerous, do not seem to have the proper food elements. In other localities, particularly in states north and east of the Ohio, are stretches of hardpan subsoil, which forbid the growth of alfalfa. And in all soils where the water table comes near the surface at any time in the year, alfalfa cannot be successfully grown.

Preparing the soil.—When alfalfa is to be laid down for a term of years, it is important that the

land on which it is sown shall first be well cleaned, either by summer fallowing it, or, what would be better, by growing some crop on it that is given clean cultivation. It is also important that the ground shall be plowed deeply in preparing it for the alfalfa, or, what would be better perhaps, in preparing it for the cultivated crop that is to precede the alfalfa. Subsoiling the land will usually be found a good investment. But this should never be done by running the ordinary plow twice in the same furrow, except in soils that are as rich in available plant food in the under furrow slice as in the upper one. Otherwise the plants from the newly sown alfalfa may not be able to get food enough to produce a vigorous growth when they are young. But when alfalfa is sown along with other plants to provide pasture, it is not so necessary to have the land in such a perfect condition of preparation, owing to the limited period during which it will be grown.

Sowing.—The time for sowing alfalfa varies much with the locality. It should not be sown in the winter or in the summer. In the northern half of the republic it is usually sown in the early spring, as soon as the ground has become warm, and the danger from severe frosts is past. In the southern half thereof it is sown in the autumn and also in the spring. When sown in the autumn, sufficient time should be given to the young plants to make enough growth to enable them to pass the winter safely, with its frequent periods of trying temperatures.

The method of sowing is by no means uniform. When alfalfa is sown as the sole crop, there is no

better way of putting it into the soil than by sowing it with a seed drill of proper construction. But oftentimes it is broadcasted. When thus broadcasted, it may be advantageously covered with a light harrow, with the teeth straight or aslant, with the roller alone, or with the roller followed by the harrow, according to the nature of the soil. When sown with a nurse crop, as, for instance, a thin seeding of oats to be cut for hay at the earing stage, the alfalfa seed is likely to be sufficiently covered if it has been sown by any process in front of the drill tubes. And the same is true of other seeds, as clover and timothy, sown along with the alfalfa. But sometimes it is further necessary to roll the land, and, it may be, to harrow it with a light harrow, the teeth being set at a backward slant. When sown on some of the weedy lands of the south, it has been found profitable to deposit the seed in rows and to keep the plants clean the first year by cultivation.

To provide pasture, alfalfa is sometimes sown in short rotations along with one or more varieties of clover and timothy. The author has thus grown it with no little success in Ontario. And there may be other combinations in which it can be successfully grown under some conditions.

When alfalfa is grown to furnish hay, thick seeding is recommended, not less than twenty pounds per acre, and in some instances more than that amount, that the stand of the hay may be of fine growth. This will reduce the waste in feeding the hay. To provide seed or winter pasture, it should be sown less thickly, about fifteen pounds per acre is considered sufficient. When sown along with

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clovers and timothy, the following combination is a good one, viz. :—

	Per acre
Alfalfa	4 lbs
Medium clover	2 lbs
Mammoth "	2 lbs
Alsike	1 lb
Timothy	3 lbs
Total	12 lbs

Cultivation.—When alfalfa is sown in rows and cultivated the first season, as is sometimes practiced in the south and elsewhere, the cultivation may be given with the hand hoe or horse cultivator, or with both, according to the distance between the rows and to the necessity for hand labor. When the plants have reached the hight of three or four inches, and the ground has become encrusted on the surface, a light harrow judiciously passed over the crop will help it materially. When sown without a nurse crop and the land becomes weedy, as it does in nearly all instances, the mower should be run over the alfalfa once, or more frequently, during the first season, as occasion may require. And the vegetation thus cut off should be allowed to fall as a mulch for the crop, unless there should be special reasons for removing it.

If grown dependent upon irrigation, the water should be applied the first year as needed, but not less than two or three times. After the first year the water should be applied in the spring and after each cutting, but not when the alfalfa is going into the winter. Irrigating waters should never be allowed to stand on alfalfa for a longer period than forty-eight hours at a time.

Pasturing.—Alfalfa may be made to furnish excellent pasture for horses, cattle, sheep and swine,

but the pasturing must not be done in an indiscriminate manner. It ought not to be pastured at any and every stage of growth, nor at all seasons of the year. It should seldom, if ever, be pastured off the season that it is sown. It is somewhat of a delicate plant when young, hence it is easily injured the first season. Neither should it be pastured in the late autumn nor during the winter in cold latitudes. Such pasturing would likely prove fatal to the alfalfa, hence probably the prevalent opinion that it cannot be pastured at all in the winter season. Pasturing sheep on alfalfa is attended with the greatest hazard to the plant, because of their habit of cropping plants closely. Most satisfactory results are obtained from pasturing horses and swine upon alfalfa.

Horses and swine can be pastured on it at any season without serious hazard to the animals. The plan of pasturing off alfalfa with horses, introduced and practiced by Mr. C. H. Larrabee of Home Park, Montana, at his Brooknook ranch in that state, would seem to be a good one. His alfalfa is irrigated. His first crop is cut for hay. The second growth is allowed to remain. Weanling colts which are also fed grain are then turned in upon it in the autumn. Later, older colts, and still later, horses, are grazed upon it, and as spring approaches, cattle are turned in to clean up the residue of the pasture. The animals are also given alfalfa hay when they require it. And ranchmen further to the southwest also adopt a somewhat similar mode of wintering their cattle. The re-seeding of the ground thus every year would seem to maintain a stand, despite the depasturing.

Alfalfa furnishes a grand pasture for swine.

They may feed upon it through all the growing season if supplied with water. They will grow nicely on it without other food, but a little grain, as corn, for instance, can frequently be fed to advantage. Swine pastures should be mowed occasionally to secure a plentiful supply of tender and succulent alfalfa.

If cattle and sheep are pastured on alfalfa when it is in a succulent condition, and more especially when wet with dew or rain, the alfalfa is liable to produce hoven or bloat, unless the animals have partaken of other food before being allowed to graze on the alfalfa. Sometimes they may be pastured for a whole season without harm; at other times the loss is serious. But when the alfalfa is growing amid other grasses, the danger from this source is much lessened.

Observations.—1. Alfalfa may be sown with much propriety in permanent pastures when the conditions will admit of it. Its continuity in them will depend upon such conditions as the nature of the soil, the encroaching character of the other grasses, and the closeness of the pasturing.

2. One acre of alfalfa will furnish pasture to from ten to twenty hogs through the entire season of growth, dependent, of course, upon the age of the hogs and the conditions relating to growth in the pasture.

CHAPTER VI.

LEGUMINOUS PLANTS OTHER THAN CLOVER.

Chief among the leguminous plants other than clover that have heretofore been grown on this continent to provide forage are the field pea, the common vetch, the cowpea and the soy bean. The field pea and the common vetch have hitherto been grown chiefly in Canada, and to a less extent in the United States that borders on Canada. But during recent years the vetch crop of the states of Oregon and Washington is assuming proportions of some magnitude. The sand vetch has been grown in a tentative way in various parts of the United States, and the cowpea and the soy bean have been grown in the southern states and to a less extent in those that are central. The peas and vetches are all of a more or less trailing habit of growth. The soy bean has more of the bush form. All of these have been found excellent food plants in the localities which have special adaptation for growing them.

THE FIELD PEA.

The field pea *(Pisum sativum)* is of many varieties. These are variously distinguished, as by the length and strength of the straw, the more or less trailing habit of the growth, the size and number of the pods, the size of the peas and the relative number

Fig. 14. Eight Plants of Green Field Pea.
——Minnesota University Experiment Farm.

in each pod, the color of the blossoms and the color and shape of the peas.

In the United States, peas are usually spoken of as "Canada field peas," whatever the variety may be. The term is a misnomer, for many varieties of field peas are grown there which did not originate in Canada (Fig. 14). Under the supervision of the author, more than eighty varieties of field peas were grown at the Ontario experiment station at Guelph in 1893, only a very few of which were first grown in Canada. The term originated probably in the fact that the earlier importations of seed peas into this country came chiefly from Canada.

The field pea, as is generally known, is of an upright habit of growth until it reaches a certain hight from the ground, more or less according to the presence or absence of wind and rain. Then it falls over unless sustained by other grain sown along with it, and it completes its growth in a recumbent position. It is this trailing habit of growth that renders it unsuitable for being grown alone to provide pasture for any kind of live stock except swine. And it is because of this habit of growth that the pea is usually sown along with one or the other of the cereals to provide pasture for sheep.

In Ontario a very large area is sown with peas every year. These are grown chiefly for the grain food which they furnish, but also for the winter fodder obtained from the straw when cured. And in Ontario and some parts of the United States they are being somewhat freely grown in combination with other grain to provide soiling food for summer use and fodder in the unthreshed form for winter feeding. Peas are also sown along with oats or

other grain to furnish pasture for sheep and swine. The peas improve the quality of the pasture because of the rich flesh-forming and milk-producing food which they furnish. But when thus grown it should be on lands with special adaptation for growing the peas, otherwise the cereal grown along with the peas is likely to crowd them. Such pastures are not so well adapted for being grazed down by horses and cattle, because of the greater injury which they cause the peas through treading. But it is when sown alone that peas are more commonly grown as a pasture for swine. This chapter will consider only the growing of peas for pasture, although it may be mentioned here that the process of growing peas for swine forage is essentially the same as when growing them for the grain.

Distribution.—Peas usually succeed best in a cool and also in a moist climate in which the summer temperatures are not extreme in their variations and where the nights are cool. But a moderately cool and even temperature is more important relatively than moisture in the air, otherwise certain of the Montana and other Rocky mountain valleys would not be able to grow peas with and without irrigation according to the locality, and in such magnificent form. Hot and dry climates are ill adapted to the growing of peas, and more especially where winds hot and dry are apt to prevail at that season of the year when the peas are coming into bloom. At such a time intense heat of the sun or the warm breath of continued hot winds would hinder the blossoms from producing pods and grain in the perfection of development, and if sufficiently prolonged the vines would shrivel and wither without fruiting at all.

Peas may be grown as a grain crop with marked success in nearly all the tillable portions of the United States and Canada above the 45th parallel of north latitude, that is to say, in all places north of the latitude of Bangor, in Maine, St. Paul, in Minnesota, and Salem, in Oregon. They can also be grown quite as successfully in some localities two or three degrees south of this parallel, from the Atlantic to the Mississippi and also in Oregon on the Pacific slope. And in some localities much further south it is very probable that peas can be grown in good form where the altitude is sufficient.

The highest adaptation for peas grown without irrigation is probably found in the states of Washington and Oregon and in British Columbia, on the slopes nearest to the sea (Fig. 15). The highest adaptation when grown under irrigation is probably found in the inland valleys of Montana, Idaho, Washington, Wyoming and Colorado. The most general adaptation in any one state or province is probably found in Ontario, with Michigan and Wisconsin close seconds. And the highest adaptation on the prairies is probably found in North Dakota, northern Minnesota and Manitoba.

But peas can be grown successfully for forage and soiling food much further south than the line drawn as the southern limit of highest production of grain. This is more especially true when the peas are grown in combination with other grain. When grown thus for pasture, the grain, of course, is not considered, and when grown for soiling food it is not so important relatively as when the peas are grown for the fodder.

Place in the Rotation.—If a crop of peas is

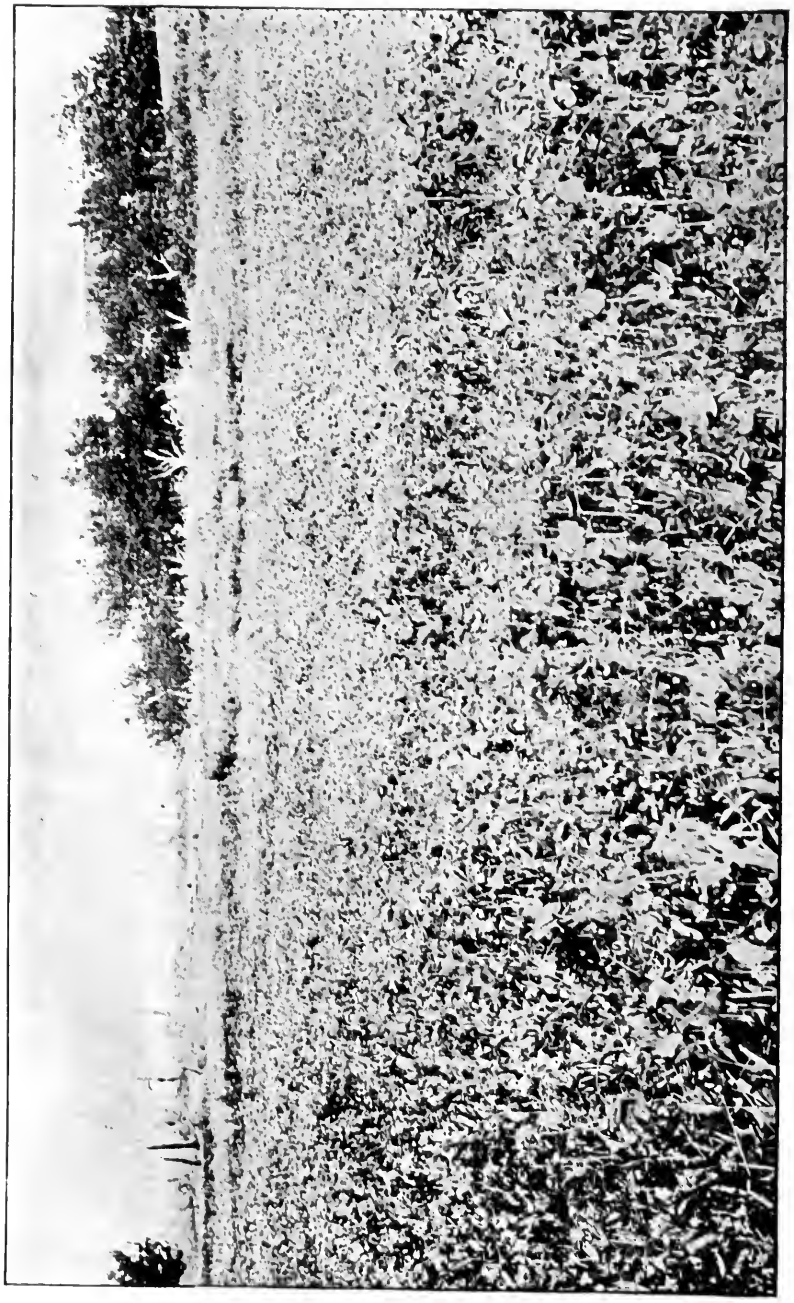

Fig. 15. Field Peas, Noosack Valley, Washington.

grown until mature on a piece of land and then harvested, the land will contain more nitrogen than before the peas were sown on it. It is evident, therefore, that the pea should be grown with an eye to preparing the land for a crop that requires much nitrogen, as, for instance, a crop of wheat or other cereal, or a crop of corn. It is also evident that it can be grown successfully on soils lower in plant food than would suffice to produce a maximum crop of any one of the cereals, at least so far as concerns the presence of nitrogen in the soil. If the ground is properly prepared it may be successfully grown on land that is foul with certain forms of weed life, as, for instance, annuals. But peas should not be grown on land infested with certain perennials, such as the Canada thistle.

Theoretically, peas should not be sown on overturned sod. It is commonly considered better practice to give these lands up to other grain crops, as oats, because of the abundance of the vegetable matter which they contain. Notwithstanding, peas grow handsomely on such land, the other conditions being right, owing probably to the moisture which is held for the peas by the grass roots as they decay, and they put sod lands in excellent condition for being followed with a cereal crop. Peas may be succeeded with much advantage if grown alone by winter wheat or rye, where the former can withstand the rigors of the winter. When followed by one or the other of these crops, the land requires only to be disked in preparing it, unless the soil should be foul with weed life.

Soil.—The best soil for peas is a mild, porous and moist clay loam, free from superfluous water

in the soil or subsoil during all stages of the growth of the plants. Sandy loams are good if moist, but not so good as clay loams. Peas will grow fairly well on stiff, unyielding clays, but not so quickly as on clay loams. Dry, sandy and gravelly lands deficient in moisture are poor pea lands. The black humus soils of the prairie are prone to grow too much straw for good yields of the grain. But this is not objectionable when the peas are grown for sheep forage along with other grain, or to provide soiling food. And muck lands are ill adapted to growing peas for pasture or for the grain, since the vines run chiefly to straw. While peas are rather easily injured by drouth, if the soil on which they are growing should be saturated with water for any considerable time during their development, it would be fatal to the growing of the peas.

Preparing the Soil.—In preparing the soil for peas, the aim should be, first, to plow the land in the autumn unless where there are good reasons for not doing so; second, to plow it deeply; and, third, to make a fine seed bed. In localities where the winters are long, open and rainy, the land should not be plowed in the fall. Nor is it necessary when the peas are broadcasted and then plowed under. When sod is plowed for peas, and more especially if it is plowed for them in the spring, the furrow slices should be narrow and laid at an angle of about forty-five degrees. When peas are broadcasted on land thus prepared, they fall down in the depressions between the cone or crest of the respective furrow slices. And when in covering the seed the harrow is run straight along these furrow slices and at one or two different angles over them, it drags

down the earth into the depressions and in this way covers the seed. If the sod were turned over in broad furrow slices and left in a flat state, it would be necessary to use the disk cultivator to make a proper seed bed.

It is not common to manure the land for peas, but manure will be very helpful on poor land. Farmyard manures are nearly always in order. When commercial fertilizers are to be used, phosphoric acid and potash are likely to be more helpful than nitrogen.

Sowing the Seed.—When peas and oats are sown for sheep pasture, about three bushels of the combined mixture should be sown, but for some soils a less quantity will suffice. About equal parts by measure of each kind of seed should be used, but there may be reasons for varying these proportions; as, for instance, when the oats grow more vigorously than the peas it would be necessary to increase the proportion of the pea seed sown. The small varieties of field peas should be preferred, as they produce more forage. The seed may be mixed and sown with the drill, taking care to bury it deeply, as deep as three to four inches. Sometimes the peas are first sown broadcast and the land is then plowed, as deeply on light prairie soils as four to six inches, and then the oats are drilled in less deeply. But on the whole, the first method is to be preferred when it is the proper thing to plow the land in the fall for the reasons, first, that the moisture is better conserved; second, that the labor is less, and, third, that the harrowing subsequently given by way of cultivation may be more thorough than when the oats are planted less deeply. And here it may be mentioned

that on firm soils where there is usually ample rainfall it is not necessary to sow peas so deeply.

When peas are sown to furnish food for swine, the method is no way different from that of growing them for the grain. Not less than two bushels of the seed of the small varieties should be sown per acre, and not more than three and one-half bushels of the large varieties. All things considered, the small varieties are to be preferred. The aim should be to sow the peas with the drill, and as in sowing them for sheep pasture, to bury them deeply. Of course they can be broadcasted and plowed under, but the same objections will apply as when peas are sown thus to provide sheep pasture. Peas should never be broadcasted and covered simply with the harrow, except on sod land, the narrow furrow slices of which are laid up as described in the preceding section, or, in other words, as sod furrows are usually turned over by Ontario plowmen. But it may be admissible sometimes to disk in peas on properly prepared land. When covered with the harrow some of the seed remains unburied, and if dry weather should follow, the peas will suffer much more than if they had been buried deeply. This one factor alone may make the difference between success and failure.

Peas sown for the grain they will produce, for sheep pasture and for swine forage, had better be sown as early as the land can be worked nicely in the spring. But for the two purposes last named, there may be good reasons for sowing them later, and as a rule the roller should follow the seed drill.

Cultivating.—The only cultivation required by peas sown for sheep pasture or for swine forage is a thorough harrowing. This should be given to

them before the seed appears above ground. It is not necessary that the harrow teeth shall go deeply into the ground. It is better that they should not do so, but the surface of the ground should be all stirred, even though the harrow should have to be driven anglewise across the field after the first harrowing to accomplish the end sought. When the surface of the soil is thus stirred, the weeds that have sprouted are likely to die, and before they are up again the peas are likely to be away ahead of them. The stirring of the soil also enables it the better to hold the moisture. But there may be reasons where such harrowing cannot be done because of an excess of moisture. So much the worse will it be, then, for the pea crop.

Pasturing.—When peas and oats are pastured by sheep, they may be turned in to graze them down when they are from six to ten inches high. The sheep should not be allowed to pasture on them, for various reasons, when they are wet. If, when the pasture is grazed down, the sheep are shut away from it, the grain will soon spring up again, and vigorously in moist weather, and will therefore furnish pasture a second time, and even a third time under some conditions. Peas and oats furnish an excellent and a safe pasture for sheep and lambs. It is excellent because of its marked palatability, because of the amount which it furnishes, and because of its timeliness. It comes in at a season when much milk is wanted for the lambs, and much milk is sure to be the outcome if the dams are grazed upon this pasture when it is succulent. And it is safe because no ill effects may be expected from pasturing the sheep upon it.

If the pasture should grow so fast that the sheep could not properly utilize it, the residue could be made into hay. But when so used, the sheep should be removed from the pasture some time previous to cutting the crop for fodder. And when the crop is pastured for a time and the second growth is made into hay, it will furnish the finest of hay; since the effect of the first pasturing is to cause the grain to stool out more than it otherwise would. As a result the hay will be finer. But there may be instances in which the yield of the second growth would be very light, as on heavy and poor soils in a dry season. And it should not be forgotten that if the oats are allowed to joint, or the peas to form miniature buds for blossoming before they are grazed down, their power to grow subsequently will be greatly lessened.

Peas are usually pastured by swine before they are matured, or after they are matured. When pastured before the peas are ripe, it is common to begin when the seeds are about ready to cook, and to continue the grazing until the peas are ripe or until they are all consumed. If the swine are turned in to glean at the stage indicated, they eat also of the green portions of the vine, hence the waste of straw is much less if the gleaning can be all done while the peas are not yet quite ripe. This can be accomplished when the patch or field is not too large.

Swine should not be turned into a field of peas green or ripe and left there for a long period at the first. There is danger that the green peas will derange the digestion and that the ripe peas will swell in the stomach so as to cause death through its

undue distension. But after a time the swine may forage upon them at will.

When foraging upon ripe peas the swine should not have a larger area to feed upon than they can consume within a reasonable time, otherwise the peas may waste much, especially in showery weather. The straw will, of course, be a total loss so far as its food value may be concerned, and yet there are areas where the lands are so cheap as to justify the practice. The straw can be burned or plowed under. In several of the Rocky mountain valleys, peas may be grown as pasture for swine in conjunction with alfalfa. The swine can be grown chiefly on alfalfa and then finished on peas, and with great profit to the grower. The swine gather the food for themselves.

Autumn pasture may also be furnished for swine when moisture is present, by deferring the burning of the straw or plowing the field so pastured. The shelled peas that have been trodden into the ground by the feet of the swine will quickly grow up and furnish excellent green pasture. But such pasture should not be sought for on stiff clays, lest the pasturing should lead to serious impaction of the land.

THE COMMON VETCH.

The common vetch *(Vicia sativa)* has not been extensively grown on our continent, even where the adaptation for it is all that could be desired. So little attention has been given to it that its merits as a food for live stock are understood and appreciated by only a very small percentage of those engaged in agriculture.

The vetch is of several species. But two of these, however, would seem to have been grown to any very great extent by the inhabitants of Anglo-Saxon speaking countries. These are the common vetch and the sand vetch, and they are the only kinds that will be included in the present discussion. They will be considered separately, because of the distinctive differences in their habits of growth and also in general adaptability.

The common vetch includes the sub-varieties known as winter and spring vetches, respectively. These would seem to have sprung from one and the same variety. The differences which now characterize them have probably been brought about by the different season at which they have been sown. The former have best adaptation for climates where the winters are mild. The latter, though best adapted to climates with cool summer temperatures, will also grow reasonably well in warm climates if sown early enough in the season.

The common vetch bears no little resemblance to the common pea in its habits of growth. But the vetch is more slender, has more tendrils and leaves, the leaves are more serrated, it bears its pods rather in clusters than singly or in pairs, and it grows more persistently when grazed or eaten off by live stock at any time previous to maturity. The seed is also smaller and is of a brown or black color. The flowers are purple.

Vetches or tares, as they are sometimes called, are much relished by live stock of all classes, and there are but few kinds of food that are equally suitable for the animals of the farm. They are excellent for milk production and their fattening proper-

ties are of a high order. They have special adaptation for being grown along with other grain to produce soiling food, and they may be made to render excellent service in providing pasture for live stock, especially sheep and swine. But when grown for hay, for soiling food or for pasture, vetches should be sown with some cereal grain to sustain them, because of their trailing habit of growth.

Distribution.—The distribution of the common vetch of the spring sub-variety is much the same as that of the field pea. But since the vetch can endure cold even better than the pea, the limit of its growth for forage lies further north, and because of its ability to withstand cold, a crop of spring vetches can be sown early enough in the Gulf states to be pastured off or cut for soiling food in time to be followed by some other crop.

The common spring vetch, notwithstanding its ability to withstand cold, has but little ability to endure extreme heat, hence in climates with hot summer temperatures it would seem to have no mission as a forage plant unless in the springtime. It would be ill adapted, therefore, to localities with severe winters and hot summers, such as are found in the upper Mississippi basin and the river basins tributary to the upper Mississippi. And since the winter vetch would be ready for grazing much earlier in states with mild winters, it would seem to be wiser, therefore, in these latitudes to grow the winter rather than the spring sub-variety.

Since the common spring vetch needs moist weather as well as cool to perfect its growth, the highest adaptation for this plant will probably be found on the Pacific slopes of Oregon, Washington

and British Columbia. Next in point of adaptation should come the maritime provinces of Canada and the New England states, and after these states and provinces, Quebec, Ontario, New York and the northern parts of Ohio, Michigan, Wisconsin and North Dakota, also Manitoba. While spring vetches can be grown further south, as stated, the hot weather of summer is against them.

The highest adaptation for the winter vetch will also be found probably in the Pacific coast states which have been mentioned as possessed of highest adaptation for the spring vetch. This is owing to the mildness of the winters, linked with the moderate and moist summer temperatures. Next to these should come the Gulf states. How far north the winter vetch will prosper has not yet been determined.

Place in the Rotation.—The vetch being a leguminous plant should be grown as a land renovator. The aim should be, therefore, to grow it on land that had borne cereals. Like the pea, the vetch will grow splendidly on overturned sod lands, but such lands cannot usually be spared for it. The winter vetch may be made to follow a crop that has been harvested, because of the late season at which it is sown. And in turn, when pastured off this vetch may be followed by some catch crop, as rape, for instance, or sorghum, according as the climate is favorable to the growth of one or the other of these. The vetch crop should, as a rule, be followed by some cereal.

Soil.—The common vetch, like the field pea, flourishes best in a moist, clay loam soil of free working texture. While it will grow most satisfactorily

in a rich soil, it will grow better relatively in a poor soil than field peas. In nearly all respects it is a more rugged plant than the pea. But very hot suns and warm winds will blight the vetch quite as readily as the pea.

Preparing the Soil.—When preparing the soil for vetches, the pulverization should be fine. For spring sown vetches, deep fall plowing is to be preferred. For autumn sown vetches the nature of the preparatory cultivation will depend somewhat on the crop which they follow. The aim should be to have the land clean, firm and moist. If the vetch follows a hoed crop, as, for instance, early harvested potatoes, it will suffice to disk the ground deeply and to smooth it with the harrow. If the crop follows a cereal, the land should be plowed some time before sowing the seed, especially in dry weather, and then it ought to be rolled and harrowed with a view to enabling it to gather and hold moisture.

Sowing the Seed.—The spring vetch should be sown for forage as early as the ground is dry enough to be worked without injury. The winter vetch ought to be sown long enough before winter to enable it to become firmly established that it may the better withstand the rigors of the winter. But it will not avail to sow it until there is enough of moisture in the soil to sprout the seed. The seed may be broadcasted, but is better sown with the grain drill, either when sown alone or along with other seed. It should be buried about as deeply as cereals. When sown alone for pasture, four to six pecks of seed per acre ought to be enough, but some authorities recommend an amount considerably larger, on the ground that when sown thus thickly the vetches

will more effectively smother weeds. When sown with a mixed crop, as winter rye or crimson clover, the proportion of the vetch seed to be sown must measurably be determined by the ability of the land to grow one or the other of the crops named. The more aggressive the crop on that particular soil the less of it should be sown. Ordinarily, from one to two pecks of the vetch seed should suffice to sow in a mixed crop, whether of the spring or winter variety. The spring vetch is frequently sown with some cereal, as oats or barley, to provide pasture.

Cultivation.—The harrow is probably the only implement that can benefit the vetch after it has begun to grow. As with peas, many of the weeds that would otherwise grow in the crop may be destroyed by a judicious use of the harrow before the vetches get above the surface of the ground. But when such seeds as rape or crimson clover are sown with the vetches, the harrowing if done at all should be done with much discrimination, and with crimson clover it would probably be better not to harrow at all. But the sowing of plants that would easily be injured by the harrowing could be deferred until the vetches were ready to be harrowed.

Pasturing. — Vetches are more commonly grazed off by sheep than by other classes of live stock. They are ready to be pastured when several inches high. If grown along with cereals, as oats, the vetches, like the oats, will come again and with equal vigor where the conditions are favorable to the growth of the vetches. Care should be taken not to pasture off autumn vetches too early nor too closely, lest the winter weather should harm them. The extent of such pasturing during the late autumn

or early winter months that would be proper in each locality cannot be stated here.

Observations.—1. But few plants grown have been found more suitable than the common vetch in providing soiling food. It would seem to be equally adapted to horses, cows, sheep and swine.

2. The hay of the common vetch is at least as nutritious as clover and it is relished even more, but it is easily injured by rain while being cured.

3. The seed is not commonly fed to live stock, but it furnishes an excellent food for them. The seed crop is more precarious to grow than that of many other farm crops.

4. It is very probable that the common vetch can be utilized with much advantage in growing pasture for swine in conjunction with clover, but this does not seem to have been proved by actual test in the United States. The seed of both should be sown early, and it will probably be found necessary to pasture the vetches so closely that they will not at any time get beyond the hight of six inches.

THE SAND VETCH.

The sand vetch *(Vicia villosa)* has but recently come into prominence in the United States. As yet it has been tested in only a few localities, and in a majority of instances only in an imperfect way. Much caution, therefore, should be observed in discussing its merits, and also the various methods of growing it, until these become better understood. In both respects the author has but little to fall back upon save his own limited experience.

The plants are naturally creeping in their habit

of growth. When young, especially, the tendrils hug the ground closely. They are tiny and spindling at first, but after a time they grow with much vigor (Fig. 16). On the cultivated plat grown at the Minnesota University experiment station in 1897, many of the plants produced each from eight to ten runners, not a few of which reached the length of eighteen to twenty feet. Each of the runners produced numerous tendrils, from, say, three to five feet in length. These so intertwined that it was almost impossible to pull away a single plant entire from the surrounding mass. When well advanced in growth the runners are tough and consequently hard to pull asunder by the animals in eating them.

Distribution.—The sand vetch is very hardy and is therefore adapted to a wide range of distribution. It is pretty certain that it may be grown in any part of the United States, although only in some localities will it be found more profitable than the common vetch. Where it cannot endure the cold of winter it will not be so profitable as when grown under conditions the opposite. It cannot be so profitably grown, therefore, in the northern states as in those further south. It has never yet survived the winter at the Minnesota University experiment station, although the uneaten forage produced by it has been injured less by severe frosts prior to the falling of the snow than the forage produced by any other plant grown at the station. It will doubtless equal the common winter vetch in hardihood, and therefore can be grown in latitudes adapted to the growth of the former. It should survive the winters, speaking in a general way, in localities south of the 40th parallel of north latitude, and also in some

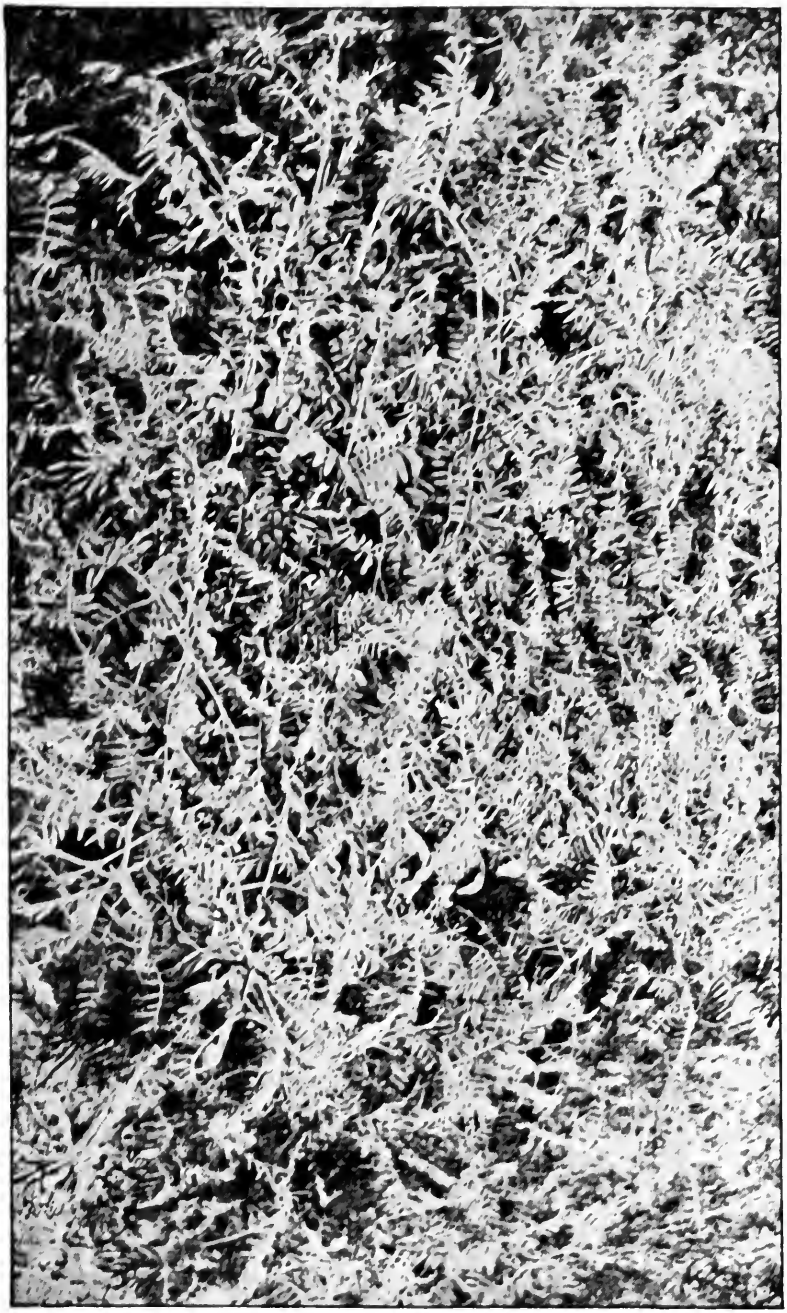

Fig. 16. The Sand Vetch in Bloom.

—Minnesota University Experiment Farm.

localities several degrees north of that line. In Canada its cultivation is not likely to prove profitable.

Place in the Rotation.—Since the sand vetch is a legume, and since it would seem to be more suitable in providing pasture than for any other use, it should usually be grown between two crops of grain, as when thus grown it has a cleaning and also a renovating influence upon the land.

Soil.—As the name would indicate, the sand vetch has special adaptation for sandy soils. It would seem to have a decided capacity to grow on light sands too poor to produce good crops of the common vetch, the cowpea or crimson clover. But it will, of course, grow more vigorously on a better class of soils.

Preparing the Soil.—In preparing the soil for the sand vetch the aim should be to secure a fine seed bed. It is not usually difficult to do so on light soils, but such soils should also be firmed by running the roller over them before sowing the seed. In some of the southern states the seed of the sand vetch may be sown on stubble land from which grain crops have been removed and then covered with the harrow.

Sowing the Seed.—Where the plants are unable to endure the cold of winter, the seed can only be sown in the spring. At the Minnesota University experiment station, results somewhat encouraging were obtained from sowing the seed along with oats. One bushel of the vetch seed was used per acre along with half that amount of oats. The oats were cut for hay when nicely out in head. A considerable proportion of the mixture consisted of

vetches. While the oats were thus growing into a crop, the vetch plants had become firmly established. Although they did not make a vigorous growth until after the oats were harvested, they then grew up and covered the ground with a dense carpet of fine foliage, which was pastured off by sheep just as the winter was closing in. The late season at which this plant can be pastured furnishes one reason why, in some instances, it should be sown rather than rape.

The attempts made by the author to grow the vetches for autumn pasture by sowing them along with oats grown as a grain crop, and in the ordinary way, were not altogether successful. The shade of the oats appeared to be too dense for the vetches. But the circumstances under which the trials were made were so unfavorable that quite a different result may possibly be obtained where the conditions are more favorable.

Where the plants will survive the winter they can be most profitably sown in the autumn and as early as the arrival of the fall rains. It is then usual to sow the seed along with winter oats or winter rye. The latter is perhaps preferable, first, on account of its greater hardihood, and, second, because of its greater ability to grow on poor land. The grain is sown with the vetch to furnish variety in the pasture and to provide stems on which the latter may climb, but when the crop is pastured, the necessity of thus providing support for the vetches would not seem to exist.

However, the grain may greatly assist the vetch in checking weed growth. The vetch starts so slowly that alone it would seem to have but little chance of ascendancy in the contest with weeds. One

bushel of the vetch seed and one-half bushel of the nurse crop are usually sown per acre. But the proportions in which to blend the seed that will be found the most suitable for each locality can only be ascertained by actual test.

Cultivation.—When the sand vetch is sown alone or with some other crop, it would not seem to be necessary, usually, to give it any cultivation. But in some instances a light harrow may be run over the land with decided advantage just before the plants appear, and later the weeder may sometimes be thus used also. It may, however, be sown in rows and cultivated. In the plot thus grown at the Minnesota University experiment station, the rows were thirty inches apart. A beautiful and dense mass of foliage was secured which lay along upon the ground to the depth of one to two feet. The yield was at the rate of 15.11 tons of green food per acre. But it will not pay to grow the sand vetch thus, because of the labor involved in keeping the land clear while the plants are young. The creeping habit of the tendrils adds much to the labor of cultivation.

Pasturing.—Unquestionably the sand vetch has better adaptability for providing pasture than for providing soiling food, fodder, or green manure. Nevertheless, some experiments in the southern states speak favorably of its adaptation to the production of soiling food and also hay. When well advanced in growth it is not easily harvested, because of the length and intertwining character of the tendrils. And, for the same reason, it is not easily buried with the plow. If pastured off by sheep when not too far advanced it should readily grow

up again and again. Figure 17 represents sheep pasturing on sand vetches, October 30, 1897. The mass of vine held aloft by the young man who appears in the picture represents a single plant. When the growth has become well advanced, sheep do not care to eat the stronger and more woody portion of the tendrils.

Observations.—1. Where the common winter vetch can be grown successfully, it will probably be found superior to the sand vetch in providing soiling food and fodder, since it is more upright in its habit of growth, is much more easily harvested and is less tough in the stems.

2. When sowing sand vetches along with winter rye or other winter crops, the plan of sowing the combined crops at the same time would seem to be a good one.

3. The sand vetch could possibly be utilized in crowding out ferns that overshadow more useful forms of growth in Washington and Oregon, by simply scattering the seed and not grazing too closely. And in the southern states it may yet be made to serve a similar purpose with other forms of weed life.

4. The seed of the sand vetch cannot be grown successfully in any of the northern states of the Union east of the Rocky mountains. At the Minnesota experiment station only a few of the pods matured seed.

THE COWPEA.

The cowpea *(Dolichos Chinensis)* is proving an unmingled blessing to the agriculturists of the United States, and more especially to those of them

Fig. 17. Sheep Pasturing on Sand Vetches.
—Minnesota University Experiment Farm.

who dwell in the southern half of the republic. It is now being grown for table use, for forage, for soiling food, and for winter fodder. But its greatest value, probably, lies in its power, first, to grow in worn and poor soils, and, second, in its power to renovate them. This renovating power arises, first, from the ability of this plant to gather nitrogen from the air and to store it in the soil; second, from the large amount of vegetable matter which it brings to the soil in its roots and also in the vines when plowed under; and, third, from the beneficial effects which it exerts upon the soil mechanically.

Formerly the cowpea was grown more as a fertilizer than as a food plant; hence it was generally considered good practice to plow under the entire crop. But since it has been demonstrated that the vines are even more valuable than the grain in furnishing food for stock, and that much fertility is stored up in the roots, the practice of using the vines and the grain as food is becoming quite common.

The cowpea resembles the bean more closely than the pea. In its habit of growth it is trailing, recumbent, semi-recumbent or erect, according to the variety and the favorable nature or otherwise of the surroundings. It has great power to gather food, even on poor soils, hence it can be grown on soils too poor even for growing clover. This fact, linked with its ability to withstand drouth, renders it simply indispensable to the farmers of the southern and southwestern states, and also to those of the central states.

The cowpea will not grow satisfactorily in a cold climate, hence, where the common field pea flourishes the cowpea languishes, and where the com-

mon field pea begins to show signs of trouble or distress, from the excessive heat, the cowpea begins to flourish; accordingly it would not be incorrect to say that the southern isothermal for the common field pea is the northern isothermal for the cowpea. Either one of these plants, therefore, may be said to be the complement of the other in the economy of our agriculture.

The cowpea is of very many varieties. These are nearly all the product of the present century, and the number is continually increasing. They differ very much in their habits of growth. These differences are such as relate, first, to the strength of the vine and the amount of foliage and fruit which it bears; second, to the character of the growth, as erect, trailing or intermediate; third, to the size, shape and color of the leaves, blossoms, pods and peas, respectively; and, fourth, to the time of maturing. These differences cannot be dwelt upon here. Among the favorite varieties in the south are the Unknown, sometimes called Wonderful, the Clay and the Whippoorwill or Speckled. Among the favorite varieties in northerly latitudes are the Whippoorwill and the Black.

Distribution.—It has already been intimated that the cowpea is a child of the sun, and that in consequence it is not adapted to cool latitudes. In its most perfect form it cannot at present be grown with marked success east of the Mississippi and north of forty degrees, that is to say, north of the cities of Philadelphia, Columbus, Indianapolis and Springfield, in the states of Pennsylvania, Ohio, Indiana and Illinois, respectively. West of the Mississippi the line would run across the states of Iowa,

Nebraska, Wyoming, Idaho and Oregon, till it reaches the Cascade mountains. It would then turn south to the northern boundary of California, which it would follow to the ocean. In some favored valleys this plant can be grown north of the line thus drawn, and on many elevations south of that line it cannot be successfully grown. But it will probably be found that north of that line the common field pea can better be made to serve any ends sought by growing the cowpea, and vice versa. But beyond all question the limit of the successful production of the cowpea will be extended further to the north in the near future. Providence is good, nature is accommodating and man is wise. By a careful choice of varieties, coupled with rigid selection of the early maturing seeds from vigorous plants, it will be found that the line of successful growth of cowpeas will be pushed much further to the north, as has been done in growing Indian corn. Within the past three months and since the above was forwarded for publication, cowpeas of the Early Black variety have been grown for pasture and grazed off by sheep with much success at the Minnesota University experiment farm, as seen in Figure 18.

Place in the Rotation.—The cowpea being a legume should be made to follow a crop that had drawn heavily on the nitrogen in the soil, as, for instance, a crop of grain or corn. And since it is a soil renovator it ought to be followed by some such crop as cotton, or corn, or sugar cane. And since in the south, where there is a long season for growth, the cowpea can be grown as a catch crop, it may be made to follow such winter crops as rye, rape, vetches or oats, and it may also be made to come

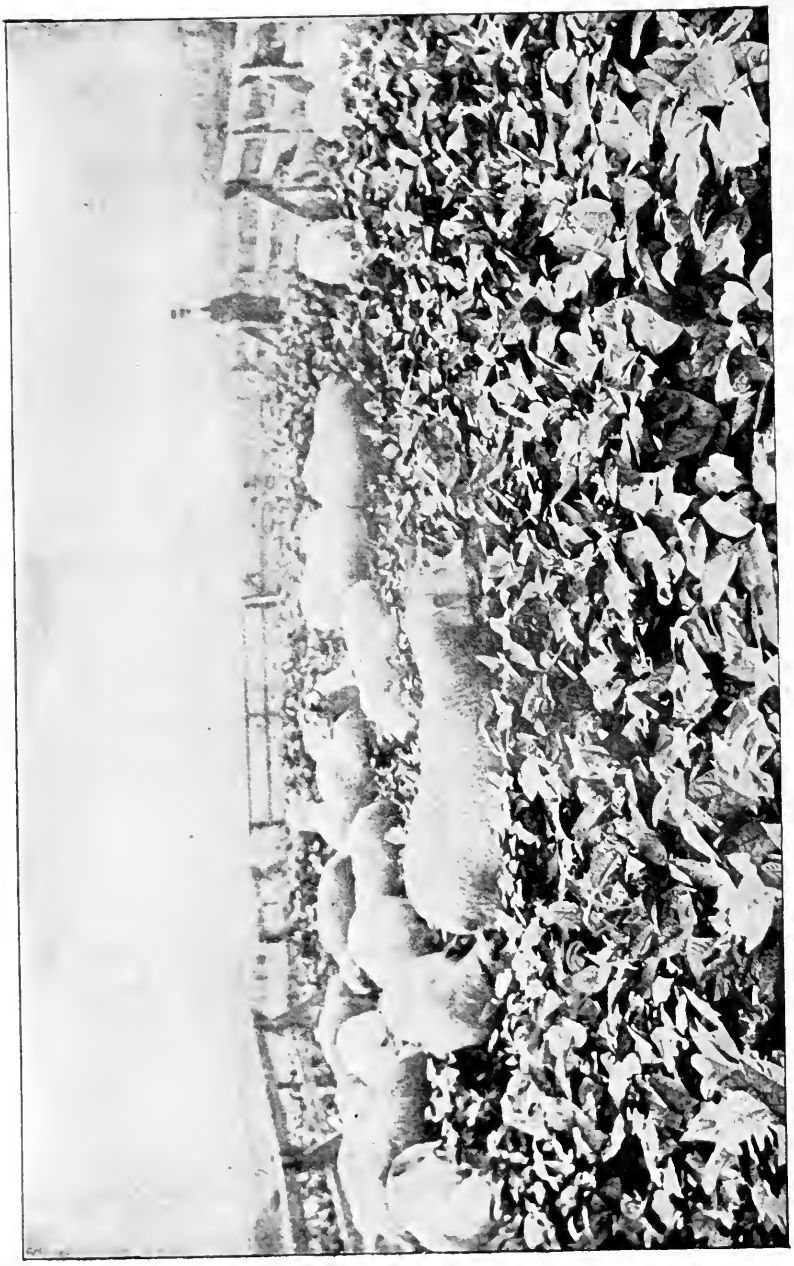

Fig. 18. Sheep Pasturing on Cowpeas.
—Minnesota University Experiment Farm.

after any garden or field crop that has been harvested early, as potatoes, for instance. When soils are much worn a crop of cowpeas turned under after rye will bring speedy renovation to the land. And if the peas should be pastured off upon the land, the soil would still be left almost as rich as though the entire crop had been buried. Hence it is that the growing of cowpeas for soil renovation and pasturing them off may go hand in hand. And since, owing to the long season of open weather in the south, two crops can oftentimes be grown in succession in one season for renovating the land, two can also be grown in one season for pasture.

Soil.—Cowpeas will grow better on a rich soil than on a soil that is poor. But in soils that are overrich, they will produce an excess of vine in proportion to the fruit which they bear. Notwithstanding, one of the grand properties of the cowpea arises from its ability to grow in poor soils. It is a deep and also a gross feeder; hence, when once started, the plants will go down into the subsoil and gather food to sustain growth in soils where various other useful farm products would pine and die.

Though this plant will give a good account of itself on poor soils even, it is much better able to do so when some fertilizer, as superphosphate, for instance, has first been applied to the land. The cowpea, however, like the common pea, will give the best returns from soils in which the clay element is present in considerable quantities. And even on stiff, red clays, the plants are able to make a strong growth. But they are easily injured by a superabundance of moisture, even though confined to the subsoil.

Preparing the Soil.—Since cowpeas in the south may be placed almost anywhere in the rotation, since they may be sown as an intervening crop and as a catch crop, and since they may be sown at almost any time during the growing season when the ground is moist enough to sprout them, the methods to be adopted in preparing the land will of necessity vary. It would unduly encroach on space to give in detail the mode of preparing the land that would suit every instance. But when so preparing it, the aim should be to secure fine tilth, a firm seed bed and enough moisture to start the crop. After a cultivated crop which has been kept clean, such as a crop of potatoes, it may be well in some instances simply to disk the land without plowing it when preparing it for cowpeas, especially when there is a scarcity of moisture. And this method of preparing the land for peas to be grown for pasture or to provide fertility after a harvested crop on clean land, may also be the best, but there may be exceptions.

On soils low in fertility it will usually pay to apply some fertilizer. While farmyard manure is admirably adapted to promoting the growth of the vines, it can seldom be spared for this crop in the south. Nor is it considered strictly economical to use it thus, since the nitrogen content in the manure is not absolutely needed by the pea crop. If nitrogen is used, it can be applied with advantage in the form of nitrate of soda. The nitrate should be sown broadcast a short time after the crop has appeared above ground. Potash when used should, as a rule, be sparingly applied, and on some soils, especially such as are covered with oak or hickory timber, it does not seem to be needed.

On the average southern soil, superphosphates seem to be the great need of the cowpea crop. The fertilizer would seem to increase the crop in proportion as it is used, up to the extent of 400 pounds per acre. But a light application, as light as fifty pounds per acre, will render much benefit to the same if incorporated with the soil in proximity to the seed. When the peas are planted in rows and cultivated, the superphosphates should be thus applied, but when they are broadcasted or sown with the grain drill, all the tubes running, the fertilizer may also be broadcasted and incorporated with the soil near the surface while the peas are being sown.

Sowing.—The time for sowing cowpeas will depend upon the climate and the purpose for which the peas are sown. Evidently the period during which they may be sown will, in some localities, cover several months. But in no case should they be sown before both soil and weather have become warm, otherwise the seed will be almost certain to rot in the soil. This peculiarity of the cowpea stands much in the way of growing it successfully in the north. The seed of this plant should seldom be sown earlier than the late corn planting season.

Whether the seeds should be sown broadcast, with the grain drill, using all the tubes, or only some of them, will depend upon conditions. The aim should be to avoid broadcasting them, since when thus sown it is not easy to cover them with the harrow so that the rain will not wash them out. But the disk harrow, followed by the ordinary harrow, could be made to provide a sufficient covering when the seed is thus broadcasted. If sown for sheep pasture, ordinarily the seed drill ought to be used,

all the tubes working. Forage fine rather than coarse will thus be secured. When sown to provide pasture for cattle, in many instances only every other drill tube is used. The pasture is then stronger, but it is also coarser than when sown with all the tubes in use. If sown only for the grain or to provide swine pasture, the rows are planted still wider, that horse cultivation may be given them. It is manifest, therefore, that the amount of seed required will vary with the object sought when growing the peas. While the amount of seed required should seldom exceed one and one-half bushels per acre, sometimes only a fractional part of that amount is required.

The combinations with which cowpeas may be grown as forage do not appear to be well ascertained as yet, but there would seem to be no good reason why they could not be grown along with corn, sorghum, rape, vetches, and other forage plants. They should have special adaptation for being grown along with sorghum for sheep pasture.

Cultivation.—Cowpeas may usually be harrowed with some advantage to the crop and to the soil a short time before they appear above the surface of the ground. But when sown by hand it may be better to use some form of weeder, lest the peas be too much disturbed by the process. Ordinarily no other cultivation is given when the crop is grown for pasture or for being plowed under, but in some instances a weeder and even a light harrow may be used with advantage after the crop has appeared. When grown for the grain the horse cultivation should be very similar to that given to a bean crop. It should be sufficiently frequent to keep the ground

clean and moist until the peas have grown so far that further cultivation would injure them.

Pasturing.—When cowpeas are pastured with sheep, the pasturing may begin before the peas have reached the blossoming stage, and when pastured with cattle, about the time that they come into bloom. But these statements are only intended to be general. There may be reasons why, with both these classes of live stock, pasturing may be commenced earlier or later. But when swine are to pasture upon the peas, the latter should be allowed to attain full size before turning the swine upon them. The least waste arises when the crop is pastured off with sheep, and it may be mentioned here that cowpeas usually spring up vigorously again when grazed off. Especially is this true of them during the earlier stages of growth.

Observations.—1. While cowpeas make excellent forage when cured properly, they are difficult to cure. They are, therefore, better adapted relatively to providing forage than hay, and this fact should not be overlooked by those who may engage in growing them.

2. Cowpeas would doubtless be much more extensively grown for hay or fodder and also for the grain, but for the difficulty in harvesting them. The "pea harvester," such as is used in Canada in harvesting field peas, should do this work admirably, but it does not appear to have been introduced into sections where cowpeas are grown. It is simply an attachment to the field mower. This attachment is inexpensive and yet very efficient. With a driver and one man walking behind to remove the bunches, cowpeas may be harvested nearly as

quickly as hay, however much the vines may trail along the ground.

THE SOY BEAN.

The soy bean *(Glycine hispida)* was probably introduced into the United States from Japan more than twenty years ago. Like cowpeas, it may be grown for the grain, for soiling food, for ensilage, for pasture and for green manuring. Its greatest value, however, will probably be found in furnishing soiling food for dairy cows, as it is in the proper condition for being thus fed at that season of the year when but few plants are available for such a use; that is to say, during the latter part of summer.

The soy bean, like the cowpea, is a hot weather plant, but it would seem to be able to stand more drouth than the former. It has much adaptation, therefore, for localities that are both warm and dry. When once well rooted, hot winds that would wilt and wither many other forms of vegetation will not seriously injure the soy bean.

Some authorities claim that the soy bean will not succeed so well on poor soils as the cowpea. Nevertheless, it can be successfully grown on soils low in fertility, and may therefore, like the cowpea, be turned to good account as a renovator of the soil.

Experience in pasturing the soy bean in the United States has not been extensive. It is impossible, therefore, at present to give its precise value as a pasture plant under American conditions. But since it is stiffer in the stem and more erect in its habit of growth than the cowpea, and in consequence is more easily broken off than the latter, it

should prove less valuable relatively in providing pasture, especially for cattle and sheep.

This plant, like the cowpea, develops somewhat slowly at first, especially in northerly latitudes, but later it grows more rapidly. In appearance it resembles a common bean, but the foliage is larger and much more luxuriant, and the habit of growth is more upright, as previously intimated. With all the conditions favorable this plant in some of its varieties will grow to the hight of at least four feet, and it produces a large yield of green food. And where the seasons are long enough, the plants lade heavily with pods which mature a food for stock that is exceedingly rich in protein.

Distribution.—The distribution of the soy bean is not very different from that of the cowpea, at least so far as concerns climatic conditions (see Page 130). But some of the early varieties, as the medium or green, can be grown successfully further north than the cowpea. The claim, however, that they will flourish as far north as corn is not quite correct, although good results have been obtained from growing them at the Massachusetts experiment station. Since the soy bean requires better land than the cowpea, its distribution will be somewhat more circumscribed, that is to say, it will be more sectional within the general area where it may be grown at its best. And since it will stand drouth better than the cowpea, it has special adaptation for some of the states west of the Mississippi and south of Minnesota, as, for instance, the states of Kansas, Nebraska, Arkansas and Oklahoma.

While the soy bean can be grown at its best in all the states south of the Ohio and east of the Mis-

sissippi, and while it is likely to prove worthy of an important place in the agriculture of these states, it is not likely that it will ever wholly supplant the cowpea. But it may prove a great aid to the latter in furnishing food and in renovating the soil. North of the Ohio and east of the Mississippi the soy bean can be grown with more or less success, even up to the Canadian border. But within much of this area it cannot be depended on to mature its seeds. For this reason, and for the further reason that clover grows well within the same area, it is likely that the soy bean will not be looked upon as an indispensable crop within the limits of the area that is being considered. When clover fails, however, it may sometimes prove advantageous to sow soy beans to supply the lack.

In the states north of the Missouri and west of the Mississippi, there is probably no place for the soy bean in the economy of the farm, unless in the triangle between those rivers at the juncture, which includes a part of Minnesota, Iowa and South Dakota. In the Rocky mountain valleys south from Montana and Washington it may grow well under irrigation, but the excellent crops of alfalfa which grow in these valleys are likely to render its growth less necessary. In Canada the soy bean is not likely ever to gain a permanent foothold, unless its properties should become considerably modified.

Place in the Rotation.—The place in the rotation for the soy bean is not far different from that of the cowpea (see Page 131). It is generally grown as a cleaning crop, and when so grown it ought to be placed between two grain crops, if it is

practicable to grow it thus. Its province as a catch crop is more circumscribed than that of the cowpea, since in many of its varieties it takes longer to mature. Nevertheless, there are many crops which it may be made to follow the same season, as, for instance, winter rye, winter wheat, grain forage eaten down, or an early crop of potatoes.

Soil.—A warm, rich vegetable soil with a porous subsoil is best adapted to the growth of the soy bean. The soils of the fertile prairie, therefore, are a natural home for it. It will also grow admirably in the russet volcanic ash soils of the country west of the Rocky mountains. On poor, sandy soils it will not make a large growth unless these are first fertilized. A moderate amount of clay in the soil is grateful to the soy bean, but an excess of clay in the soil or subsoil hinders growth. Of course a soil saturated with water during much of the period of growth would be fatal to success.

Preparing the Soil.—The preparation of the soil for the soy bean is much the same as for the cowpea (see Page 134). A reep, fine, firm and moist seed bed should be sought. But this does not necessarily imply that the plowing shall be deep when done in the early summer and on the dry soils of the prairie. When the soy bean is planted after a grain crop which has just matured, a free use of the harrow and roller should be made in a normal season to conserve moisture. When the soil needs fertilizing, those fertilizers which are most needed by the cowpea are also most needed by the soy bean, and the mode of applying them is also similar (see Page 134).

Sowing.—Soy beans are commonly sown on

level land, but there may be some few instances when raised drills would be superior. When sown for the grain, for ensilage, for soiling food or for hay they are put in with the grain drill. But they may also be planted with a corn planter or a bean planter. It is customary to make the rows about thirty inches apart. If the crop were grown for pasture the rows could be made considerably closer, under some conditions, but not so close as to preclude cultivation, except such as may be given with the harrow. There may be instances when it would be advisable to broadcast a crop of soy beans. When the rows are thirty inches apart, from two to four pecks of seed will suffice per acre. If the rows were placed closer, as for growing forage, more seed ought to be used.

The soy bean and the cowpea should grow fairly well together. The beans would furnish some support to the peas. But further experiments are required before it can be claimed that this method of growing them has any decided advantage over growing the beans separately. At no time should the seed be sown earlier than the corn planting season, and north of the 40th parallel of latitude it ought to be planted later. But south of that line, good crops have been grown, the seed of which was not planted until July. In the north, early varieties only should be sown, and even in the south very late varieties ought not to be used.

Cultivation.—The cultivation suitable for the soy bean is about the same as that which ought to be given to the cowpea (see Page 136). A harrow with the teeth aslant can be used with advantage before the beans are up, and also in some instances

Fig. 19. Sheep Pasturing on Soy Beans.
—Minnesota University Experiment Farm.

at a later period. The cultivation should be prompt and generous, more especially when the plants are young.

Pasturing.—But little can be said as to the best modes of pasturing off this crop in the present state of our knowledge. It has not been much grown for pasture, although some instances are on record where it has been so grown. There would seem to be no good reasons why it should not be pastured off by sheep and swine and even by cattle, although cattle would doubtless waste more or less through treading upon the plants. At the Minnesota University experiment station, lambs fed off the pods and leaves, but not the coarse stems. Cattle and sheep unused to soy bean pasture might not take kindly to it at first, but doubtless they would soon become fond of it. A view of sheep pasturing on soy beans is presented in Figure 19.

Observations.—1. For making hay, the soy bean should be cut when the beans in the pod are fully half grown, or before the lower leaves begin to fall freely, and the aim should be to handle it but little during the curing process, lest many of the leaves should be lost.

2. The soy bean is an excellent soiling plant, since it produces a large yield of green food per acre and very rich in quality.

3. When mixed with corn in the silo the quality of the ensilage is thereby considerably improved.

CHAPTER VII.

RAPE AND CABBAGE.

Several plants of the Brassica genus have been grown as forage for many years in Great Britain and other European countries, and so they will be, doubtless, in the near future in the United States. Only two of these, viz., rape and cabbage, will be considered here, as these are the only two species of this genus that have hitherto been grown for forage on this continent. Some of the other plants of the Brassica genus that may yet be introduced will be considered in Chapter XI. Of these two plants, rape is unquestionably the more important for forage, but the day is probably near when cabbage also will be extensively grown, more especially to provide late pasture for sheep.

RAPE.

The rape plant *(Brassica napus)* is beyond all question one of the most useful fodder plants that has yet been introduced into the United States, and so it is likely to continue through all time. In writing to the agricultural press in 1890, the author ventured the opinion that the day would come when 10,000,000 sheep and lambs would be fattened every year in the United States on rape. Why should such a statement be looked upon as extravagant? It would require only 1,000,000 acres of rape to accomplish such an end.

The rape plant has been grown for forage in Great Britain and some other countries of Europe for about 200 years. It is also probable that for many years it has been grown for a similar use in limited areas of the United States, but not to any great extent until quite recently. Its superlative value as a fodder plant for sheep is even now not known to one among a thousand of our farmers. The isolated few who grew it did so mainly as an aid in preparing their sheep for competing at the live stock fairs. Many of them did so in a sort of secretive way. So long as their competitors did not know its value, the growers of rape felt that in the show rings they would have an advantage over their rivals who were ignorant of the virtues of the plant.

In Wellington and two or three of the other counties of Ontario, rape has been grown in considerable quantities for nearly a quarter of a century, if not indeed for a longer period, but except in these counties rape does not seem to have been grown elsewhere in Canada prior to the experiments conducted with it by the author at the Ontario government farm at Guelph. These experiments began in 1889. The first bulletin based upon them appeared in 1890. At that time it was affirmed by leading seedsmen who were in a position to know that there were not 500 pounds of rape seed sold per annum to provide sheep pasture in all the United States. The same authorities have expressed the opinion that in 1897 not less than 500,000 pounds of rape seed were sold by the seedsmen of the same, that is to say, enough to sow 125,000 to 150,000 acres. It would now be hazardous to

try to fix any limits to extension in the growth of this plant.

Rape will grow in one form or another in nearly all parts of this continent. The season for sowing it usually covers a period of about three months. In some climates it covers a period considerably longer. The farmer, therefore, can generally find some spot on which to grow it without diminishing the area of the other crops grown. It can be sown in a score of different ways and under a score of different conditions. When once started it will stand much drouth and cold. If desired it may be so grown that the cultivation given to it will be found peculiarly helpful in cleaning the land (Fig. 20). It furnishes one of the finest pastures for sheep and swine that can be grown for them, and it makes excellent soiling food for any class of live stock kept upon the farm. It may be grown as a catch crop and also as a green manure. It is indeed a veritable jewel among the forage crops of this country, as in addition to the good qualities just enumerated, its food value, pound for pound, is about twice that of green clover, and it will usually grow about twice as much per acre.

The rape plant bears a close resemblance to the rutabaga in the early stages of its growth. So close is this resemblance that an expert cannot distinguish between them. The former, however, becomes more upright as it develops and produces much more of top than the latter, but its root is fusiform and therefore of no value for food purposes. Its many prongs and long rootlets penetrate the soil in all directions, hence it is a gross feeder and draws heavily on the soil. But since it is commonly pastured off by live

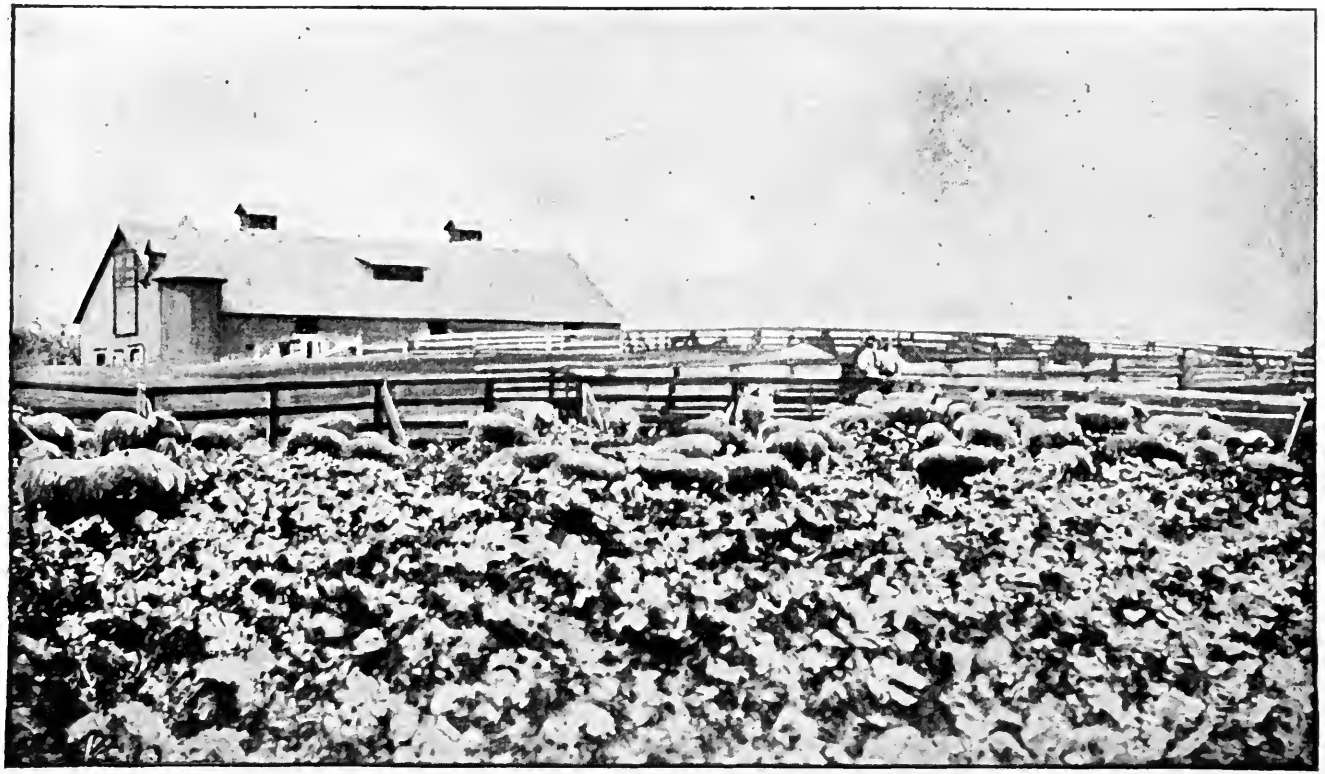

Fig. 20. Sheep on Rape Sown for Early Pasture.
——Minnesota University Experiment Farm.

stock where it has grown, the soil will not be depleted of its fertility where rape has been thus grown and pastured.

Rape is an annual. It is of several varieties. Some of these mature their seeds the same year that they are sown. Such are the varieties that are sown to provide food for certain birds and also to furnish oil. But sometimes the winter varieties are used to furnish oil. The summer varieties are not of much value for forage, since the proportion of leaf growth upon them is small, the season for pasturing them is brief, as the stems which shoot upward to sustain the seed pods when formed soon become so woody that live stock do not relish them. The varieties that are really valuable for forage do not mature seed the same year that they are sown, and of these the Dwarf Essex is probably the best. Indeed, it is about the only kind that has heretofore been thought worthy of cultivation in this country.

Distribution.—The Dwarf Essex rape can be grown with more or less success in nearly all the arable portions of the United States and Canada, providing due attention is given to the requisite variations as to the time and also as to the method of sowing it in the various states and provinces. It is what may be termed a cool weather plant, hence in growing it the best results relatively may be looked for in the states which extend northward to the Canadian boundary. And in the tier of states that lie immediately to the south of these border states, fairly good crops may be grown. But the adaptability of the republic to rape production would seem to lessen with the increase in distance from the northern boundary line, and yet there is perhaps no

state in the Union in which the rape plant cannot be turned to good account in furnishing forage, providing it is grown at that season of the year when the temperature is best adapted to its growth. Moist and moderately cool climates are the most favorable to the growth of rape, hence it does particularly well in those portions of New England where the soil is sufficiently rich to grow it, and also on the final slope of the Pacific coast, in Oregon, Washington and British Columbia. All the arable portions of Canada will grow rape in good form, but in none of the provinces does it succeed better than in Ontario.

The seed is all imported at present from Great Britain and other European countries. It cannot be grown with much success in the northern and middle states, and in the provinces of Canada, east of the Rocky mountains, owing to the coldness of the winters. In some of the states that lie pretty well to the southward and that are also favored with a goodly supply of moisture, it may be demonstrated that rape seed may be grown with success. And on the Pacific slopes, more especially those which border on Puget Sound, the indications all point to singular adaptability for the production of the seed of this plant (Fig. 21).

Place in the Rotation.—When rape is sown in drills and properly cultivated it becomes a cleaning crop which may be made as effective as the best managed bare fallow in cleaning the soil. If thus grown it may be given any place in the rotation, but on account of the beneficent influence on the crops that follow, it may be well to sow it on land that needs to be freed from superabundant weeds. When

Fig. 21. Rape Grown for Seed.

—Whatcom County, Washington.

sown broadcast it ought to be on rich and clean land, otherwise the growth will not be sufficiently vigorous, and the weeds may choke the rape. If sown as a catch crop or as a green manure it may be made to follow any kind of crop, as occasion may require, even though weed seeds may be abundantly present in the land, for the pasturing or the plowing in of the crop, as the case may be, can be done sufficiently early to prevent the maturing of weed seeds in the rape.

This plant may usually be broadcasted with advantage on overturned sod. The abundance of the vegetable matter furnished by the grass roots promotes growth, and such lands are not so liable to be filled with weed seeds or other germs of plant life, as lands that have been cropped successively with grain for a term of years. If rape is sown after winter rye, or mixed grains or corn that has been eaten off, two crops may thus be obtained in a single year from the same piece of sod. Such cropping is favorable to the clearing of the land, howsoever the rape may be grown. And the same is true when it follows cereal crops or clover that has been harvested at maturity. It may also be grown with much advantage on land that is being summer fallowed, whether the rape crop is turned under or pastured off. The aim should be to follow rape that has been cultivated with some cereal crop, because of the favorable condition in which it leaves the land for growing these crops.

Soil.—Rape is best adapted to what may be termed deep, rich, moist and free working soils, well stored with humus. It grows magnificently in muck soils not unduly saturated with water during the

season of growth. On stiff clays, the seed is slow of germination, and subsequent development on this class of soils is also slow. On poor, sandy lands it may start quickly, but the growth will not be vigorous unless fertilizer in some suitable form has been freely applied to them. When moisture is present, good farmyard manure is particularly favorable to the growth of rape. Nor would it be easy to supply the manure in excessive quantities. Commercial fertilizers rich in phosphates have been found valuable in stimulating the growth of this plant.

Preparing the Soil.—In preparing the soil for rape, much will depend upon its nature, upon the character of the season, and upon the time of year when the rape is sown. But, in any event, the aim should be to have the seed bed fine, moist, and as clean as it can be made under the conditions. When the crop is sown early, moisture is usually present in ample supply. If it is sown in the late spring or during the summer the roller should follow close upon the plowing to prevent the escape of moisture. When the seed is sown early, or when the rape crop follows just after the removal of another crop, but little can be done by way of sprouting weed seeds with a view to destroying them before sowing the rape seed; but if it is not sown until the season is advanced and on land not previously cropped the same year, there is ample time to clean the land on and near the surface before the rape is sown.

Sowing. — The time for sowing rape will depend, first, on the object sought in growing it; second, on the nature of the season; and, third, on the character of the climate. Rape sown for pasture will usually reach a maximum growth in from

eight to twelve weeks from the time of sowing the seed. To provide sheep pasture, rape is not commonly sown until after the season for planting corn, as it is in the autumn that such pasture is most wanted. But to provide swine pasture it ought to be sown early, and also later at successive intervals. In countries with moist autumns and mild winters, it may be advantageous to sow the seed in the autumn.

The method of sowing will depend upon such conditions as the nature of the climate, the strength of the soil, its cleanness or the opposite, whether the seed is sown alone or along with another crop, and on the nature of the machinery at hand for sowing it. The more moist the climate, the stronger the soil and the cleaner the land, the less the hazard in broadcasting the seed. The drier the climate, the poorer the soil, and the more foul the land, the greater the necessity for sowing in drills that cultivation may be given. When cleaning the land is one of the objects sought in sowing rape, it should always be sown in drills. If sown with another crop it must usually be broadcasted. The broadcasting is commonly done by hand, or by using some form of hand seeder, but when the seed is put in rows and sown on large areas, it is put into the soil with the grain drill, or with a two-row turnip drill.

The amount of seed required will also vary with the conditions. When rape is broadcasted and where it is the sole crop grown upon the land, from three to five pounds of seed are required per acre. If drilled in rows, from one to two pounds are used. The stronger the soil and the more favorable the

conditions for growth, the less the quantity of the seed required. When the seed is broadcasted, it is commonly covered with one stroke of the harrow, and may or may not be rolled subsequently with advantage, according to conditions. If drilled in, much benefit will result from following the seeder with the roller, unless where the soils are so light as to carry with the wind. In moist climates it will be advantageous to sow in raised drills, otherwise the rows should be on the level.

Rape may be sown with corn to provide pasture, as described in Chapter II. It may also be sown in the same just before the last cultivation given to the corn, when the corn is "laid by" for the season. When thus sown, an average of three pounds of seed may be used per acre. It can be most easily sown from the saddle. The seed is carried in a sowing box in front of the rider and is held in place by shoulder straps. The cultivation that follows should be light. After the corn crop has been removed, the rape is pastured. The value of the pasture thus furnished will depend upon the character of the soil and season, and on the lack of denseness in the shade furnished by the corn. When the late summer and autumn weather are both dry, and when at the same time the shade of the corn is dense, but little pasture will be provided. Under the opposite conditions, however, and where the winter closes in tardily, much pasture may be thus grown.

Rape may also be grown along with sorghum, as described in Chapter III. And in many instances it may be sown with much advantage along with all the common cereals, as wheat, oats, barley and rye, whether these are grown singly or in conjunc-

tion, for the grain or to produce soiling food. When thus sown, from one to two pounds of seed per acre will suffice. There is not so much hazard in sowing the lesser quantity named, since in a very dry season no return may be realized. The largest return in pasture is likely to be obtained from sowing the rape seed along with barley, and the smallest from sowing it with oats, because of the less dense shade furnished by the former, and the more dense shade furnished by the latter. With winter wheat or winter rye, the seed may be sown in spring, as soon as the ground is dry enough to sustain a span of horses without taking injury from their treading upon it. It should then be covered with the harrow. With the other crops named it may be mixed with the grain at short intervals while it is being sown. This method of sowing the rape seed is best suited to the loam soils of the prairie. On the average soils of the northeastern states and of the eastern half of the Dominion of Canada, it would bury the rape seed too deeply.

A second and probably a better method of sowing the rape seed with these crops would be to put it into the seed box of the grass-seed-sowing attachment of a grain drill, and to have it fall in front of the tubes which sow the grain. On many soils this would furnish a sufficient covering for the seed, but not on all. The same amount of covering would also be secured by sowing the seed by hand, or with a hand sower before the drilling in of the grain. Where more covering is desired the harrow will furnish it.

When the rape seed is sown thus early, there is some danger in moist seasons, and especially with a

barley crop, that the rape will grow so vigorously in the barley as to interfere with the harvesting of the same. This seldom happens with any of the other kinds of grain, and it does not happen very often with the barley crop. But it may be prevented by sowing the rape seed one or two weeks after the barley is sown. The objection to sowing it thus arises from the fact that it is likely to go unharrowed. If, however, the rape seed is sown just when the first blades of barley begin to appear, a light harrow with the teeth slanting backward may be used (but not always), with decided advantage to the rape and also to the barley.

In an average season and on good soils, no easier method of sowing rape for pasture can be adopted. But there is not the same certainty that pasture will be obtained as when the rape is the sole crop grown on the land. Sometimes an excellent crop of fall pasture will result and at other times there will be little or none. It would not be wise to sow rape thus on hard or infertile land.

Cultivation.—When rape is sown broadcast, no cultivation other than harrowing can be given to it. It is a hardy plant, and if sown thickly enough to allow for a small proportion of the plants being torn out, it may be harrowed under some conditions with positive advantage. But it is not usual to harrow rape that has been broadcasted.

If rape is sown in drills, the cultivation should begin as soon as the plants are easily traced in the line of the row. The cultivator should run near the plants, especially at first, but not so as to bury any considerable number of them. Shallow but thorough cultivation should follow at intervals, until

the leaves are not far distant as they reach out toward the center of the space between the rows.

It is not common to thin the rape, because of the amount of labor involved, although larger crops would result if it were thinned. Unless the land is quite foul with weeds that grow rapidly, the rape will generally choke the weeds in the line of the row. But large weeds should be struck out with the hoe or topped back rather than have them go to seed.

Pasturing.—Rape may be pastured off at various stages of development, according to the object sought. When eaten down before it has made a maximum growth it will grow up again with more or less vigor. The strength of the second growth will be proportionate to the character of the soil as to texture and richness, to the character of the season as to moisture or the opposite, and to the nature of the pasturing. The richer and moister the soil, the more moist the weather, and the earlier and less close the depasturing, the stronger will be the second growth of the rape. But depasturing should not commence in any event until the rape has become well established in the soil, that is to say, until it has made a growth of several inches. And in pasturing off rape with a view to getting a second or a third growth, the animals which feed upon it are very prone to crop it off so closely that the capacity of the plant to grow again is weakened. This is particularly true of sheep. Experiment has not told us whether more food will be obtained from allowing the rape to approach the maximum of development before it is eaten down or from pasturing it off at two or three successive intervals. But in the judg-

ment of the author the first system will furnish considerably more food than the second.

Rape may be pastured off with horses, cattle, sheep, swine and fowls. Horses and cattle waste more through treading than the other classes of live stock named. Cows in milk should not usually be allowed to pasture on rape lest a taint be given to the milk, but it may be cut and fed to them after each period of milking. Neither cattle nor sheep should be turned in upon rape when hungry, lest they eat too much of it and so induce bloating, which, in a very short time, may prove fatal. And when the rape is wet from rain or dew, the tendency in the rape to produce bloating is increased. And in climates where moisture abounds, the danger from bloat is greater than when moisture is not plentiful. The author has observed that in the country drained by the Mississippi and its tributaries, the danger from bloating in animals pasturing on rape is less than from pasturing them on the same in New England, eastern Canada and the further Pacific slope north of California.

Cattle and sheep may be accustomed to rape by turning them into a field of the same after they have eaten freely of some other food and then leaving them in the rape pasture. But the danger will be still further decreased by allowing them to remain on the rape only for a short time the first day, and by gradually increasing the time during each succeeding day. In less time than a week they may be allowed to remain on the rape, having access at will at the same time to an adjoining grass pasture, for reasons given further on. In thus accustoming a large flock of sheep to a rape pasture, the aid of a

saddle horse will be found serviceable, owing to the difficulty of walking through a heavy crop of rape on foot.

When animals that have never been pastured upon rape are first turned in upon it, they may not take kindly to it, not having acquired a taste for the rape, but if confined to it they will soon eat it ravenously. So fond do they become of it that ere long when feeding upon a mixed pasture in which rape is one of the factors, they will first search out the rape and consume it in preference to almost all other kinds of plants. And when once they have acquired a taste for rape they never tire of it.

If live stock are pasturing on rape it is generally considered beneficial to the animals to give them access also to a grass pasture. And if the grass in the latter has lost some of its succulence through age, the benefit will be increased. The grass lessens the tendency to "scours" in the animals, that is to say, it lessens the tendency to a too lax condition of the digestion. Grain, as oats, for instance, fed once a day at the rate of, say, half a pound per head for each animal, will have a similar effect upon the digestion. But it is not usually considered necessary to feed grain to live stock that are being pastured on rape, for the sole object of hastening the fattening process, as it is doubtful if any kind of grain can be added to rape pasture in a mature stage of growth that will cause the sheep to lay on fat much more quickly than if they are pastured on rape alone. Cattle and sheep should always have free access to salt when pasturing upon rape, and when necessary they should also be supplied daily with water. But when sheep are pasturing upon suc-

culent rape in the autumn, they will drink little or no water.

If sheep are turned in upon a rape pasture that is neither very tall nor very dense, they will first consume the leaves because of their greater succulence. They will finally consume all the stems, eating them off close to the ground. But if the rape should be tall and thick they will feed it off clean, or virtually so, as they pasture. The stems are considered even better for laying on fat than the leaves. When the leaves, but not the stems, of a rape pasture have been eaten by sheep, if cattle are then turned into the same to complete the depasturing, there will be much less loss of rape by trampling than if the cattle had been turned in at an earlier stage of the depasturing.

On soils that do not poach, that is to say, on soils in which the hoofs of the sheep do not sink beneath the surface, sheep may be pastured upon rape with profit until the closing in of winter. And it may yet turn out that in warm latitudes they can be pastured on rape through the whole of the winter. Oftentimes they may be pastured on it with profit after the first snows have fallen. But in climates with cold winters, rape should be eaten off before the arrival of severe frosts. After the rape has been frozen until the stems become so crisp that they are easily broken asunder, the value of the rape pasture is much impaired. And when the early frosts cover the rape with rime, the sheep should not be allowed upon the rape until after they have partaken of a feed of oats or other suitable grain. In the absence of such food they should not be given access to the rape until the frost has lifted. or serious digestive troubles may arise.

Observations.—1. The rape crop is sometimes said to be severe on land, that is to say, that it will soon deplete the soil of its fertility. That will depend on the use to which the rape is put. If pastured off by live stock, as sheep, for instance, that remain upon the field while they are depasturing the crop, it is difficult to see how it can deplete the soil of its fertility, since what has been produced is put back upon the soil.

2. It should be remembered that clay lands are unsuitable for being pastured in moist weather, even by sheep, when they are carrying a crop of rape. If they are thus pastured off when in the condition stated, the land will be so impacted as to render subsequent cultivation both difficult and costly.

3. The number of sheep that one acre will sustain, and the period through which it will sustain them, will, of course, depend upon the character of the growth in the rape. But an average crop will sustain from ten to fifteen animals per acre for sixty days. At the end of the sixty days they should all be in condition to "take the market," even though lean in form when put upon the rape.

4. When sheep eat so excessively of rape or of any other fodder plant as to induce bloating, relief must be at once given or the animals will almost certainly die. And they will die with great suddenness. When they are being pastured on rape in large numbers, therefore, a trocar should always be on hand. The moment that a case of bloat is detected, the paunch should be tapped to allow the gas to escape. This is done by striking the trocar into the stomach on the left side and somewhat low down in the triangular fleshly space

between the last rib and the hip. Sheep die so quickly from bloat that medicine given is seldom of much value. But if animals dying or just dead from bloat are at once bled, the meat is not injured as food.

CABBAGE.

Cabbage *(Brassica oleracea)* has been grown to some extent as a soiling food for sheep, both in Europe and America, but so far as known to the author it has not been grown to provide pasture for sheep elsewhere than at the Minnesota University experiment farm. The experiments there conducted were carried on under the direction of the author, and they have been quite successful, in fact, encouragingly so. No plant grown at the said farm has furnished more valuable food for sheep to the acre. The field thus opened for growing this plant will prove surely a very wide one.

Although very similar to rape in its food constituents, a crop of cabbage, when well matured, will sustain less injury from frost, and consequently will provide pasture later in the season. A second advantage that cabbage has over rape as a pasture plant, arises from the fact that there is even less hazard in growing the former. It cannot be said that the cabbage has more of inherent vigor than rape, but the mode of cultivation which it requires is almost certain to insure a crop even in the driest seasons. There is certainly a wide future before this plant in providing pasture for sheep.

Distribution.—Cabbage, like rape, can be successfully grown in nearly all sections of the United States and Canada. But, like rape and rutabagas,

it can be grown more successfully in cool and moist latitudes than in those that are warm and dry. But cabbages can be successfully grown in warmer latitudes than either of these crops. Wherever they can be successfully grown for table use without too great an expenditure of labor, they can also be successfully grown to provide sheep pasture.

Place in the Rotation.—Cabbages may be successfully grown for forage anywhere in the rotation, but since they should receive cultivation while they are growing, they should preferably be put on ground that requires to be cleaned, and should ordinarily be followed by a crop of grain sown with grass seeds.

Soil.—The best soils for growing rape are also the best for growing cabbage, and these have been described previously when treating of rape. But it is even more important that the land shall be rich when growing a crop of cabbage on it than when growing a crop of rape. Cabbage can also be successfully grown on land that has too much clay in it to grow rape well. It would not be wise, nevertheless, to grow cabbage for forage on such land, as pasturing off the crop late in autumn would tend very much to impact the soil.

Preparing the Soil.—In preparing the soil for cabbage, the ground should, as a rule, be plowed deeply the autumn previous. But there may be localities, as those with winters open and rainy, where it would be better not to plow in the autumn. If not rich naturally, it should be made so by turning under a free application of farmyard manure, in a somewhat advanced stage of decay. Where the soils are leechy, the manure should be spread over

the surface after the land has been plowed. Usually it is not necessary to plow the land again in the spring, but it ought to be deeply stirred with the cultivator as early as the work can be done, and a succession of harrowings may also be in order. The number of these will be somewhat dependent on the time at which the seed is sown. The earlier the seed is sown the less the opportunity that will be given for thus sprouting the weeds on and near the surface.

Sowing.—The time for sowing the seed will depend, first, on the character of the climate; second, on the variety of the cabbage; and, third, upon the season when the crop is to be depastured. Sowing should be deferred until danger from frost is past. If early pasture is wanted, then the seed of some early or semi-early variety should be sown, and as early as the sowing may be safely done, otherwise some late variety should be chosen and the sowing deferred until the soil has been well cleaned and mellowed. About the corn planting season will be found a very suitable time for planting cabbage seed of the late varieties, and those varieties should be chosen that have been found well adapted to the locality.

When a limited area is to be sown, after the ground has been thoroughly pulverized it should then be rolled and the rows marked off with some form of hand marker. They should vary in distance from thirty to thirty-six inches, according to the variety of the cabbage and strength of the soil. The seed may then be sown with a hand machine. The roller should again be passed over the soil where the wind is not liable to blow it away. When a large area is to be sown the drills may be slightly

raised by using a double mold-board plow and marker, and the seed sown with a machine drawn by a horse, and which sows, covers and rolls two rows at a time. Or it may be sown on the level, after the ground has been rolled, with a grain drill capable of sowing properly so small a seed. There are grain drills that will do such work nicely. When they are driven with sufficient care the rows will be straight enough to admit of easy cultivation. Of course, the openings for seed in the drill must all be closed, except those which are to be used in sowing the cabbage seed.

The amount of seed required will vary with the variety of the cabbage, with the strength of the soil, and with its condition as to moisture. But, as a rule, less than one pound per acre should not be sown and more than two pounds will seldom be needed.

It will generally be found cheaper to sow the plants thus than to grow them elsewhere and then transplant them into the rows. When they grow too thickly they are quite as easily thinned as turnips or rutabagas. The work of thinning can be done even more quickly in the case of cabbage, as they are to be thinned to a greater distance. In some sections it would scarcely be possible to grow cabbage plants after this fashion, because of the ravages of insects and because of the slow growth that they would make when young on certain soils. Where they cannot be grown thus, it is at least questionable whether the attempt should be made to grow cabbage as forage.

Cultivation.—As soon as the cabbage can be distinctly traced in the line of the row, the cultiva-

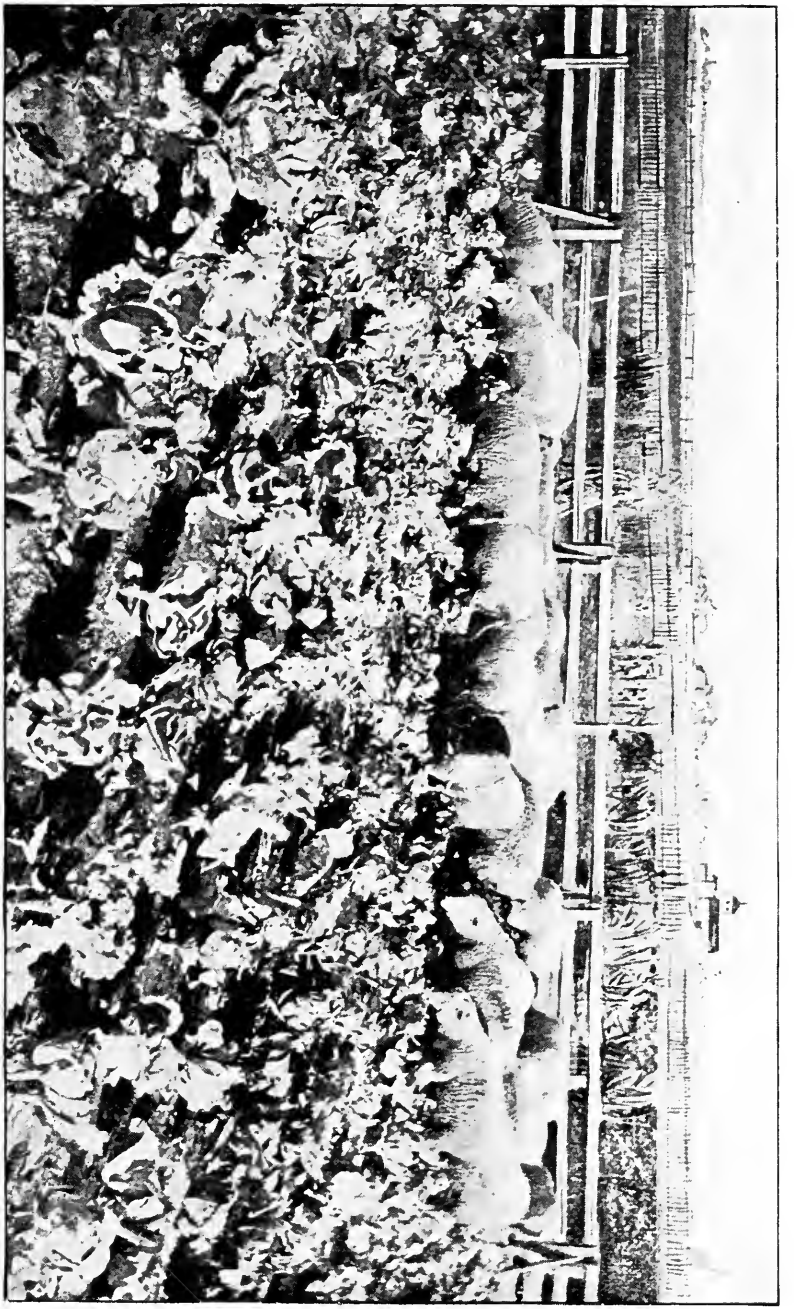

Fig. 22. Sheep Pasturing on Cabbage.
—Minnesota University Experiment Farm.

tion should begin. It should come as near to the young plants as possible without covering them. And it should be frequently given and continued until it cannot longer be done lest the leaves of the cabbage be broken. The thinning of the plants should begin when they are from three to four inches high. The work is nearly all done with the hoe. The individual doing it stands squarely in front of the row, that is to say, he faces it, not standing too near, and strikes out the plants which intervene between those which are to be left. Of course, the strong plants are to be left, and to secure such an end it may be necessary sometimes to vary a little in the distance to which the plants are to be thinned. The proper distance between the plants in the line of the row will vary with the conditions, but the aim should be to secure large heads in the cabbage, hence they should be thinned accordingly. From twenty to thirty inches between the plants in the line of the row may be named as the two extremes of close and wide thinning, respectively.

Pasturing.—Cabbage are best adapted to provide pastures for sheep. Although they are especially adapted to furnishing autumn pasture, the season of pasturing should not be too long deferred in localities with cold winter climates, as, if the crop is not all eaten before winter closes in, the part uneaten will be lost. In sections with mild winter climates, the pasturing may go on far into the winter season. Figure 22 represents sheep pasturing on cabbage.

As the sheep are turned into a cabbage pasture, the same care should be exercised as with rape, that the change of diet shall not be too suddenly made. When used to the new diet, the sheep may be left

on the cabbage all the time, or they may also be given access to a grass pasture, as may be convenient. If given time enough, the sheep will eat the entire crop save the stalks.

Observations.—1. Cabbage for sheep pasture may be grown with special reason where the soil will grow an abundance of rutabaga tops, but will not produce good roots, and where severe early frosts would injure rape.

2. This crop will produce a very large amount of pasture high in nutrition.

CHAPTER VIII.

THE COMMON CEREALS.

Wheat, oats, rye and barley are included in the term, common cereals. In the popular idea, peas also are included, though not a cereal in the strictest sense of the term. With the exception of rye, these grains are seldom used singly in providing pasture. But they are frequently grown in combination for such a use. When thus grown, it is believed that more pasture will be produced than could be obtained by growing any one variety alone. This arises mainly from a difference in the habit of the growth of the plants of each variety, first, as to quickness of growth, and, second, as to stooling properties. For instance, if oats and barley are sown in combination, the barley, because of its more rapid growth, will furnish the bulk of the pasture during the earlier grazing period, while the oats will furnish the bulk of the same during the later grazing period. And the oats will stool more than the barley. Good grazing may be furnished, therefore, for a longer period by growing the two in combination than by growing either singly. The variety thus afforded is also advantageous, on the principle that variety in grass pastures is advantageous.

Pastures from these grains will not be equally serviceable in all parts of the United States. They will be serviceable, first, in proportion as grasses

and clovers grow shyly or not at all in any locality; second, in proportion to the success which attends the growing of cereals for pasture; and, third, in proportion to the lack of success which attends the growing of plants of the sorghum family for pasture. While pastures of more or less value may be obtained from cereals in all parts of the United States in which cereals can be grown with success, it will follow, therefore, that they will render the best service in states that lie in the upper half of the Mississippi basin, and in the arable portions of Canada which drain into Hudson Bay. Cereal pastures will be less valuable relatively in the eastern, more especially the New England, states, and in the provinces of Canada which extend from Lake Huron to the Atlantic. In these areas the rainfall is usually abundant and well distributed. The soils are also of heavier texture than in the west, and the protecting snows are more abundant in winter, hence the conditions are relatively more favorable to the growth of grass pastures than in the prairie states and provinces. In the former, the cereals not only grow more slowly, but more difficulty is experienced in grazing them off, from liability to impaction of the soil through the treading of the stock. Over all the southern half of the United States the conditions are more favorable, relatively, to growing pasture from the saccharine and non-saccharine members of the sorghum genus.

Pastures from cereals are usually obtained, first, by sowing winter rye; and, second, by sowing the "small" grains, as rye, wheat, oats and barley, in various combinations. Under some conditions, cereals may also be pastured, in some instances,

for a time and with profit, by sheep, even when they are to be harvested for the grain which they produce.

WINTER RYE.

Of the cereals, rye *(Secale cereale)* is beyond all question the most suitable for forage uses. It is an annual, and, therefore, it is usually necessary to sow it every year. But instances are on record in which it has been pastured for a period considerably longer than a year, by keeping it eaten off closely. The various kinds of rye may be divided into two classes, one of which is known as winter rye and the other as spring or summer rye. The winter varieties are much more valuable than the spring varieties in providing pasture, since the former are frequently grazed both autumn and spring, whereas the latter furnish pasture for a short season only in the early part of summer. The great value of winter rye as a forage plant is not as generally understood as it ought to be, or much more of it would be sown to grow forage.

Distribution.—Rye can be grown for pasture in all, or nearly all, the tillable portions of the United States. Where lands are irrigated, it may not always be profitable to grow rye for pasture, but, of course, on these it may be thus grown, and in great perfection. As a forage crop it will probably be more valuable relatively in those areas where grasses and sorghums do not grow at their best. Hence, it may be made to render peculiar service in providing forage in all parts of the upper Mississippi basin, and in the regions of Canada which drain into Hudson Bay. In some portions, however, of the

Hudson Bay basin, the low temperatures of winter will preclude the possibility of growing winter rye. Although extremely hardy, even more so than any of the clovers, there are low temperatures which it cannot survive. Winter rye also renders yeoman service in furnishing forage in latitudes with mild temperatures, and more especially when the air in these is moist and the rainfall sufficient. In such areas the season for pasturing the rye is more continuous and prolonged than it can possibly be where the winters are long and cold.

Place in the Rotation.—Rye for pasture may be placed anywhere in the rotation. This is more particularly true of winter rye. But since it becomes in a sense a "cleaning" crop when another crop immediately follows the depasturing, it will be found good practice to sow it on land that requires cleaning. As the period for pasturing in the spring is of but short duration, there is ample time to follow rye pasture with corn, potatoes, sorghum in any of its varieties, field roots, millet, or rape. Such a succession cannot but prove destructive to weeds, and the only sections where it cannot be adopted successfully are those in which the rainfall is so meager as to prohibit the growing of these crops the same season, after the rye has been eaten off.

Soil.—Winter rye may be successfully grown for pasture on any soil possessed of the requisite fertility and moisture. It has much power to gather food in the soil, hence, even on poor soils, it will make a fair growth when supplied with the needed moisture. On the other hand, the vigor of the growth will be proportionate to the richness of the

land, and to the ease with which the rootlets of the rye can gather food from it. Rye has peculiar adaptation for sandy land, hence on such land it may be grown for forage with a fair measure of success, although too poor to grow other cereals in good form. On stiff clay soils, the growth is slow. A further objection to growing rye on such soils for pasture arises from the fact that grazing it off in wet weather so tends to impact the land as to render subsequent cultivation difficult and more or less unprofitable.

Preparing the Soil.—When the moisture is ample, the preparation of the soil for winter rye is a simple process. The land only needs to be plowed and pulverized so as to produce a fine tilth, that is to say, a fine condition of pulverization on the surface and for some distance below it. Under these conditions, the plowing of the land may be deferred until the time approaches for sowing the rye, if it is more convenient to have it thus, but where moisture is deficient it would be necessary to plow the land some time previously. When thus plowed, it should be at once rolled with a heavy roller or packed with a subsoil packer, as conditions might require. The harrow should follow within a few days, and after an interval one or more subsequent harrowings may be necessary. Ground moisture sufficient to sprout the rye can thus be arrested near the surface, unless under conditions extremely adverse. In the absence of enough moisture to sprout the rye, it would be useless to sow it. Where a crop of peas has just been removed from clean land, it is usually not necessary to plow before sowing the rye. Disking it once or twice will be found a suffi-

cient preparation when followed by more or less harrowing. The second disking should be made so as to cross the first.

Sowing.—The best time to sow rye for pasture will depend upon the amount of moisture in the soil, the severity of the winters, and the extent of the pasturing that is sought. No good can come from sowing the rye on a soil with insufficient moisture to produce germination. If there should be only moisture enough to start germination and not enough to sustain it, the young plants must perish. In some instances, therefore, it may be necessary to defer sowing for several weeks after the ground has been made ready.

Where the winter climate is severe. the aim should be to sow the rye sufficiently long before the advent of winter to enable it to make a good growth in the autumn. When the roots have a strong grip on the soil, and when the "top growth" made is sufficient to act as a mulch, the rye is enabled, especially in the absence of snow, to endure the rigors of an open winter with much less injury than if the plants entered the winter with but little of development. Later sown winter rye ordinarily makes but a feeble growth in the early spring, even though it should not be seriously harmed by the cold of winter, and it is in the early spring that rye pasture is especially valuable.

If pasturing the rye in the autumn is an important consideration, then, of course, the rye must be sown early, as early as August in the northern states, somewhat later in the central, and still later in the southern. In the northern states and in Canada, the aim should be to sow rye for pasture not

later than the middle of September, whether it is to be eaten down or not in the autumn. It may survive though not sown until near the advent of winter, but late sowing is not likely to produce an abundance of pasture in the spring, although in some instances it may produce a good crop of grain.

Rye should be sown thickly when it is to be pastured. Not less than two and one-half bushels of seed per acre should be used, and on some soils three bushels will prove more satisfactory. The less favorable the conditions, the greater should be the amount of seed sown. It is more satisfactory to put the seed in with the grain drill than by any other method. The grain drill buries the seed to a uniform depth, hence all of it is more likely to grow. The roots are nearer the sources of moisture, and since they are deeper than would result from broadcast sowing, the plants suffer less injury from adverse winter weather. The depth to plant the seed will vary with the conditions, but ordinarily from two to three inches will suffice.

Cultivation.—Usually no further cultivation is necessary after the rye has been sown, but in some instances it may be harrowed with advantage in the early spring. The stirring thus given to the surface of the ground tends to promote the growth of the rye and to discourage the growth of weeds. In dry regions it will also render good service in the extent to which it will prevent the escape of ground moisture. If grass seeds have been sown upon it, the harrowing renders the "catch" of the seeds more certain. But sowing grass seeds on rye that is to be pastured is of doubtful advantage, owing to the

early period at which the depasturing ought to begin. There are some soils on which sowing grass seeds may prove quite successful.

Pasturing.—Rye pasture is excellent for all kinds of live stock. It is particularly helpful in producing an abundant milk flow, before it reaches the jointing stage. Live stock may be turned in upon it in the autumn as soon as it has made a sufficient growth to furnish a "good bite," and likewise, also, in the spring. Sheep may be put upon it earlier than cattle, because of their greater ability to gather food from short pastures. It should be kept so closely grazed that it will not joint. As soon as it joints to form the head, its power to produce much pasture, and also good pasture, is gone. And when not eaten until the jointing stage has been reached, live stock will not then relish it because of the woody character which it assumes. It should also be remembered that when rye has been pastured for a considerable period in the autumn, it is not likely to produce so much pasture in the spring as it would had it not been so pastured. Plants, like people, exhaust their powers when they have done a certain amount of work.

More food would be obtained by dividing the rye into two or more sections and alternating the grazing. But this may seldom be practicable because of the labor and expense involved. When sheep are being pastured on rye, if they are given some concentrated food at the same time, as, for instance, oil cake or corn, both sheep and land will be much improved. When cows in milk are being pastured on rye, they should not be allowed to graze upon it more than two or three hours per day, and only just

after they have been milked, otherwise both milk and butter will be affected adversely.

Observations.—1. Winter rye is not altogether satisfactory as a pasture plant when sown in the spring. It will make a good and rapid growth for a time, but when the hot weather of summer comes, it usually turns a sickly, rusty color, and in very dry weather dies outright. This, at least, has been the author's experience in growing spring sown winter rye, both in Ontario and Minnesota. Several other cereal plants will furnish more and better pasture when sown in the spring.

2. Winter rye is sometimes pastured with swine from early spring until the crop has been harvested by the swine. When thus pastured the rye is in excess of the immediate wants of the swine, and consequently it forms ears that mature. In many instances it may be well to remove the swine for a time to prevent breaking it down unduly until the grain is nearly matured. The grain is then consumed by the swine. Much of it will, of course, shell out and become more or less imbedded in the ground by the trampling of the swine. In moist weather, it soon springs up and in turn furnishes late summer pasture. If clover has been sown on the rye in the early spring, the pasture will be much improved in consequence, when a good "catch" of the clover is obtained. This method of furnishing food for swine has met with some favor in Ohio and elsewhere, but it does not seem to find much favor as yet with the average farmer.

3. When rye is sown in the late summer with a view to pasturing it in the autumn and also in the spring, Dwarf Essex rape seed may be sown along

with the rye, and generally with no little advantage. From one to two pounds of rape seed should be sown per acre, and, in some instances, a larger quantity. The seed may be sown, first, by adding it to the rye in the drill grain box at short intervals and mixing it with the rye while the latter is being sown; second, by the grass-seed-sowing attachment to the grain drill, when it has one—the rape seed should fall before rather than after the grain tubes, that a covering may thus be provided for the seed; third, by some other form of seeder, or by hand, after the rye has been sown. One stroke of the harrow should then be given to cover the rape seed. Rape sown with rye does not grow so vigorously as when it is the sole occupant of the ground, but if sown five or six weeks before the pasturing begins it will usually add much to the value of a rye pasture, and more especially when it is to be eaten down by sheep. But the rape will not live through the winter, as the rye does, except in mild latitudes.

4. The few trials that have been made in growing rye and crimson clover together have not proved altogether satisfactory. Although these plants are frequently sown at the same season, one is liable to be weakened by the growth of the other. In localities quite favorable to the growth of crimson clover, as, for instance, the state of Delaware, the clover unduly shades the rye, and in places where the opposite conditions prevail, the rye may unduly crowd the clover. But when both are kept grazed off, the author fails to see why these should not be grown with much advantage together in providing pasture, at least under some conditions.

5. Rye may be pastured for a time in the spring

and still produce a good crop of matured grain the same season. The pasturing tends to make the rye stool more than it would without being pastured, but if the grazing is continued too long, the plants will be so weakened that the heads will be small, and, consequently, the yield of the grain will be light. The best time to remove the live stock cannot be stated, conditions vary so much, but the drier the weather, the "slower" the soil, and the poorer the land, the earlier should the live stock be removed.

6. If the rye should joint and so get beyond the power of the stock to feed it down, it should be plowed under, and not later than the earing stage. When thus buried, in a normal season, it will give the land much increased power to hold moisture.

MIXED GRAINS.

Pastures from cereal grains grown in combination are not only more productive, relatively, in some sections than grass pastures, but they can be grown any season, hence they may be made to supplement the latter in whole or in part when they may have failed from any cause, or combination of causes. They are especially serviceable in providing pasture for sheep and swine, since they are injured less by treading than if pastured with cattle and horses, but on many of the western prairies they may be turned to excellent account in providing pasture for either cattle or horses. While these pastures are variously formed, the following are the more common of the mixtures sown, viz.: 1, peas and oats; 2, barley and oats; 3, wheat, barley and oats; and, 4, wheat, barley, oats and rye. The place given to these pastures

in the rotation, the soils suitable to their growth, the mode of preparing the soils, of sowing the seed, and of feeding them off, are essentially the same.

Distribution.—Although grain pastures may be grown successfully in any part of the country in which grain will grow successfully, they are especially adapted to prairie soils, for reasons already given. The first of these mixtures is considered the most suitable in providing pasture for sheep and swine. Oats for seed may commonly be obtained cheaply, and pea vines furnish palatable and nutritious food. Peas would be much injured by the treading of horses and cattle. The second mixture, viz., barley and oats, is a favorite in providing pasture for swine, more especially in those portions of the northwestern states in which clover has not yet been successfully grown. But it will answer equally well in providing pasture for sheep, and in many parts of the country it can be more cheaply produced, since barley is cheaper, relatively, than peas. The third and fourth of the mixtures are more commonly sown to provide pasture for horses and cattle. Peas are not included in them, because of the injury the peas would receive from being trodden upon by the broad hoofs, and because of the greater relative dearness of the seed. In the upper Mississippi and Hudson Bay basins, therefore, they will render the best of service.

Place in the Rotation.—These pastures may be given any place in the rotation that may be convenient. When grass seeds are not to be sown upon them they may be grown upon land that is foul with weeds, for the reason, first, that the grazing of the pastures prevents the weeds from maturing their

seeds, and, second, that the pasturing season is over sufficiently early to admit of following with a catch crop the same season, or of fallowing the land. Soils thus managed would be much cleaner at the close of the season than at its commencement. If, however, grass seeds are to be sown on these pastures, they should be grown only on clean land.

Soils.—The most suitable soils for these pastures are those ordinarily found on the northwestern prairie, that is to say, loam soils rich in humus, with enough sand in them to keep them free-working, and, withal, resting on a subsoil of clay. Any soil that has been found peculiarly adapted to the production of heavy crops of grain will also grow good cereal pastures. And these may also be grown with much advantage on soils that produce straw too abundant and too weak for first-class yields of grain, since these pastures may be eaten down before the grain is far enough advanced to lodge upon them. In the northeastern states of the Union, and in the eastern provinces of Canada, soils of free texture should be given the preference in growing these pastures. Infertile sands will not produce sufficient growth. And stiff clays would be greatly injured by eating down the pastures in a wet season. These pastures require soils that admit of early sowing, that will produce a quick growth, and that will not take serious harm by grazing the pastures when moist.

Preparing the Soil.—As a rule, the ground should be plowed in the fall, but to this there may be some exceptions. It should be plowed in the fall that the seed may be sown upon it early and for other reasons. Whether autumn or spring plowing

is preferable will depend upon conditions of soil and climate. The best time for plowing land to produce a good grain crop will also be the best time to plow for cereal pastures, and this knowledge will be possessed by farmers in their respective localities. It may be said, further, that the best preparation of the soil for grain production will also be the best preparation for producing grain pasture.

Sowing.—The seed of each of these mixtures should be sown as soon in the spring as the ground is in a good condition to be worked. When thus sown, more food will be produced in an average season than if sown later.

It is preferable to sow the seed with the grain drill, as it is then buried more uniformly than if covered with the broadcast seeder or the harrow. The drill is also more economical of seed, and it puts the seed so far down that the young plants are not so liable to be torn out by the harrow when the latter is run over the ground subsequent to the sprouting of the seed. When labor is not pressing, it may be well to divide the seed into two equal lots and to sow it with two casts of the drill. The second cast should be made to run at a right angle across the first. The seed should be buried at the depth that has been found the most suitable for cereals as ordinarily sown.

What is termed heavy seeding is preferred. The amount of seed best suited to the different kinds of soil will vary, hence it cannot be stated here, but, as a rule, it will prove satisfactory to sow not less than three bushels per acre of the combined grain mixture, of whatever varieties it may be composed.

In determining the proportions of each variety

of grain included in a mixture, no better general rule can be adopted than to use by measure equal parts of each. But in some instances it will be advantageous to depart from this rule. In some soils, for example, peas may grow much more vigorously than in others, and a less proportion of the peas would be required in these, and so of each of the other grains. The pasture produced by some cereals is better relished by certain kinds of live stock than that produced by others, hence more, relatively, of these should be sown.

Barley is more relished by swine than oats, thus when these two are sown to provide swine pasture, more of the barley should be used than of the oats. Indeed, barley alone makes an excellent swine pasture, but oats sown along with it prolongs the term of pasturing. Again, the seed of some one kind of grain may be so dear that it may be well to omit it from the mixture. Wheat, for instance, may be so much dearer than the other kinds of grain that it would not be advisable to sow it with them.

Cultivation.—Oftentimes further cultivation is not needed after these mixtures have been sown, but in instances not a few the harrow may be used with some benefit to the pastures, and more especially when a mixture of peas and oats has been sown. A light harrow only should be used, and with the teeth aslant, unless the surface soil has become encrusted. Usually the best time to use the harrow is just before the grain comes up. Harrowing helps to keep the soil moist and free from weeds.

Pasturing.—The most suitable stage of growth at which to begin the pasturing cannot be stated, as it will vary with the character of the season, the

extent of the pasture and other conditions. The more vigorous the growth of the plants, and the larger the area of the pasture in proportion to the live stock that are to feed upon it, the earlier should the pasturing begin. Ordinarily, it should be several inches high before turning in the live stock upon it. When it can be grazed so as to prevent the plants from reaching the jointing stage, much more pasture will be obtained than under conditions the opposite, since it will then grow again.

Such pasture is excellent for all kinds of live stock. There is no danger that the animals will be injured by bloating when feeding upon it. But care should always be taken to avoid making a sudden change from all-grass pasture to all-grain pasture, lest disturbance should arise in the digestion. Such pasture is excellent in stimulating milk production, hence lambs that are still nursing grow rapidly upon it, and cows in milk produce abundantly.

Sheep and swine may be allowed to remain upon grain pastures all the time, when the weather is dry, and the same is also true of cattle and horses, but it is not a good plan to keep the latter upon them all the time, more especially when the growth is somewhat advanced, as they injure it more by treading and lying down upon it than they would if removed from the pasture when they had eaten a sufficiency of it.

Observations.—1. It would be impossible to state just when one or another of these mixtures should be preferred under all conditions. However, peas and oats or oats and barley have been found very suitable in providing sheep pasture. Barley alone or with a moderate addition of oats makes an

excellent swine pasture. And the combination with all the cereals in it is more frequently used in providing pasture for cattle and horses.

2. The aim should be to keep the stock away from these pastures when wet with rain, or even with heavy dew, and more especially when they are rank and advanced in growth. At such times treading will soil and bruise them much more than when they are dry.

3. If the pasture gets ahead of the live stock, that is, if it becomes so abundant that much of it cannot be consumed, it will serve an excellent purpose if plowed under. But it ought to be thus buried while yet succulent, else in sections deficient in moisture it may not decay with sufficient rapidity.

4. If these pastures could be eaten down, as it were, at successive stages, that is to say, by cropping them down and then removing the live stock entirely until considerable growth had again been made, more pasture would be secured than can be obtained by constant grazing. But to manage them thus is not always practicable.

5. Winter rye may be sown with much propriety immediately after the grazing of these pastures has been completed, as it may then have a long period of growth before the closing in of winter.

6. At the Minnesota University experiment farm, the author has met with encouraging success in sowing grass seeds at the same time that the grains were sown. A good stand of grass has thus been obtained during successive years from timothy and clover sown with peas and oats and eaten down by sheep. The treading of the sheep on average prairie soils thus sown would seem to be helpful

rather than harmful to the grass. And the same would seem to be true of the treading of cattle, though in a less degree.

PASTURING CEREALS WHEN YOUNG.

On the rich soils of the upper Mississippi basin, cereals may oftentimes be pastured for a time by sheep with positive advantage to the crop. This has been demonstrated by individual farmers, but not with that exactness that could be desired. The sheep are allowed to feed upon the grain for a longer or shorter period, and then they are removed and the crop is left to mature.

Benefits Resulting.—The following are chief among the benefits resulting from such depasturing: 1, the treading of the land by the hoofs of the sheep tends to make it firmer, and because of this increased firmness, the loss of moisture from surface evaporation is materially lessened; 2, cropping off the grain when it is young tends to make it stool more, and consequently increases the number of the heads of the grain; and, 3, the pasturing hinders that excess of growth in the crop which it would otherwise have on very rich lands in moist seasons, hence the liability to lodge is lessened and the energies of the plant are centered on producing grain rather than exhausted in producing an excess of straw.

Mode of Pasturing.—The sheep may be put upon the grain as soon as it is far enough advanced to furnish them with food, or they may be allowed to roam over it from an adjacent grass pasture from the date of sowing. The duration of the pasturing will depend chiefly on the character of the season.

In a season of much growth, the sheep may feed upon the pastures for a period considerably longer than in a season opposite in character.

Good Judgment Required.—Good judgment must be used in thus pasturing off cereals. If the pasturing is too long continued the grain will not make sufficient growth. As the character of the weather subsequent to the removal of the sheep cannot be known beforehand, prudence would dictate their removal at an early period. The pasturing of cereals should probably not be attempted on land where the danger of an excess of growth is not imminent. Nor should sheep be used in thus pasturing off cereals on clay lands when these are wet, however strong the growth of the young cereals may be, as the impaction of the land that would follow would be more or less disastrous to the grain.

CHAPTER IX.

MILLET.

Millet in all its species and varieties may be made to furnish food for live stock in the form of grain or seed, fodder, soiling food or pasture. More commonly, however, it is grown to provide fodder. For this purpose it is most excellent, especially in the smaller and finer growing varieties. But to furnish fodder at its best, it should be cut as soon as fully headed out, or very soon after reaching that stage, and it must be cured with care. Under favorable conditions, in some of its varieties, it produces enormous yields. Of the small varieties, however, the average yield may be placed at one to two tons per acre. If the seeds are allowed to mature or to approach maturity, the fodder rapidly becomes woody, hence its value for food is much impaired. When fed in a ripe condition, there is some hazard in feeding it indiscriminately to certain kinds of live stock, but this would not seem to hold true of millet hay cut at the stage indicated. It furnishes excellent soiling food and at a season when it is much needed.

Heretofore, millet has not been much grown to provide pasture, but in this respect also it has a mission. On the bare fallow of the prairies it may be grown as a pasture with much success. In addition to the food furnished, the land will be benefited by the treading of animals while pasturing upon it.

Nor would it always be necessary to replow the land after the millet when preparing it for the crop which would next be sown. And on any farm where live stock are kept, it may sometimes be pastured with advantage. But because of its value for hay, and because of the ease with which it may be cured and handled as hay, it is usually considered of too much value to grow it as pasture. The pasture is much relished by all kinds of farm animals, since the leaf growth is abundant. But it is not equally so in the different varieties.

There are many kinds of millet, and the distinctions which characterize them have not heretofore been very clearly drawn. The following classification, however, submitted by the department of agrostology at Washington, D. C., would seem to be incomparably the best that has yet been made. It divides the cultivated millets into four groups, viz: The Foxtail, the Barnyard, the Broomcorn and the Pearl millets.

The first group includes the varieties derived from the various species of the genus *Chaetochloa* (Setaria). To this group belong the common millet, the German, the Hungarian and the Golden Wonder. Common millet, of which there would seem to be several varieties, does not produce so abundantly as the other members of this group. The heads are small and likewise the seeds. German millet, sometimes called "Golden," from the rich color of the heads, is characterized by a plentiful production of leaves. The heads are thick and heavy and are covered with short, fine hairs. They have a plump and heavy appearance when fully developed. Hungarian millet is sometimes called

Hungarian "grass." It has a long and slender head, and the heads are of a darker shade than those of the German variety. Golden Wonder millet produces large and long heads. The panicle is somewhat branched, that is to say, it is made up of many miniature heads attached to the central stem of the same. This sort is well adapted to the production of grain. Of the Foxtail group the German variety is probably the best for pasture under average conditions, because of the abundance of the leaves which characterizes it.

The Barnyard millets include the varieties derived from the common barnyard grass *(Panicum crus-galli)* and such related species as *P. colonum* and *P. frumentaceum.* The Japanese kinds belong to this group. These are of much larger and coarser growth than the Foxtail millets. The leaves are very long, and as they approach maturity they become pendent. The heads are very large and produce an abundance of seed. The Japanese millets are adapted to the production of soiling food rather than to the production of pasture, but under some conditions they may be grown for the latter purpose also.

The Broomcorn millets are derived from *Panicum miliaceum.* They are so named, doubtless, from the resemblance of the head or panicle to the brush on broomcorn. The varieties are exceedingly variable and are as yet not well understood in America, hence it is not possible to classify them at present with unerring accuracy. They are relatively better adapted to produce seed than to provide pasture. One variety of Broomcorn millet, now grown somewhat extensively in the northwestern

states, is frequently called "hog millet," from the extent to which the seed has been grown to provide food for swine.

The Pearl millets include varieties belonging to the various species of *Pennisetum.* One kind of Pearl millet *(Penicillaria spicata)* is sometimes called "cat-tail millet," from the marked resemblance of the panicle to the common cat-tail *(Typha latifolia)* of the swamps. It is like corn in the tall and upright habit of its growth. It is like teosinte in its tendency to produce an abundance of leaves and suckers, and it is like sorghum in its habit of bearing seed on a head which grows on the upper extremity of the stem. When planted on rich soil and cultivated, it will grow to the hight of eight to ten feet. As many as ninty-five tons have been grown per acre on very rich land from three cuttings in one season. When cut off or eaten down it springs up again quickly and with much vigor. It should, therefore, be valuable as a pasture, as soiling food or as fodder, providing it is found sufficiently palatable. If cut when approaching maturity, or even after the head has appeared, it may be easily cured, and in the same manner as corn. But it is difficult to cure if cut before the heading-out stage. Some authorities speak discouragingly of its value as a food for live stock. The experience of the author in growing it at the Minnesota University experiment station will not permit the unqualified acceptance of such a view.

Distribution.—Millet in one or the other of its varieties may be grown so as to mature its seed in nearly all parts of the United States and Canada where the land is tilled. This wide distribution

arises from the short period required to enable the crop to perfect its growth. Some of the smaller varieties will mature in sixty to seventy-five days from the date of sowing, under favorable conditions.

These conditions include a good soil, warm weather and a sufficiency of moisture. In some portions of Canada, as Manitoba and Assiniboia, for instance, these varieties do not require a much longer period to mature their growth than in states far to the south. This is owing to the heat and to the long hours of sunlight which characterize the summer days in these northerly climes. But, since some of the large varieties, as Pearl millet, for instance, require about 150 days to mature seed, these are not well adapted to being grown in the northern states to provide winter fodder. Some of the Japanese varieties, however, will perfect their growth in the inland portions of the continent as far north, at least, as the latitude of St. Paul. Since millet cannot flourish where the mean summer temperatures are low, it is somewhat lacking in adaptation to the maritime provinces of Canada, as New Brunswick, Nova Scotia and Prince Edward Island. Nor has it special adaptation for the New England states, although good crops of millet may be grown in these. The mean summer temperatures of Oregon, Washington and British Columbia between the mountains and the sea are also rather low for millet, and the same is true of the elevated Rocky mountain valleys. In the lower of these, however, it will flourish if given moisture. In what is termed the dry belt west of the Mississippi river, in some seasons millet may fail because of the lack of moisture at the proper season for sowing the seed.

The prairies of the Mississippi basin and its tributaries have marked adaptation for the growth of millet, and this adaptation would seem to be the most complete in loose soils not very well adapted to the growth of hay and some other grasses.

Place in the Rotation.—Owing to the lateness of the season at which millet is sown, it is frequently grown as a "catch" crop, that is to say, as a crop where that which previously occupied the land has failed, or between two crops. It may thus be made to come after winter wheat which has suffered so much from the severity of the winter weather that it is not worth while leaving it. It may come after spring grain that has succumbed to such adverse influences as frost, too much or too little moisture or to the ravages of insect pests. And with much appropriateness it may come after clover that has been winterkilled, for then nitrogen, its favorite food, is plentiful in the soil. But there is no place, probably, where millet can be grown with more appropriateness for pasture than when it is sown on the bare fallow.

It is possessed of peculiar adaptation for being thus grown on the loose soils of western prairies, since these are usually improved rather than injured by being trodden upon by live stock. When thus grown it interferes with the growth of no other crop. It may be eaten off at any stage of growth desired, and without injury to the fallow in any instance where a due regard is had to the conditions while it is being grazed down.

Millet may be followed by any crop that it is desirable to grow, but since it greedily preys upon the fertility of the soil and absorbs much moisture

from the same, there may be seasons in which it would be unwise to follow millet with winter wheat or winter rye. But when the millet is pastured rather than made into hay, the drain upon the fertility and also upon the moisture in the soil is much less than when the millet is grown for hay or for seed.

Soils.—The soils best adapted to millet are those rich in humus. Such are the soils of swamps and slough lands, basins or pockets surrounded by higher land, the lesser and also the greater valleys in clay sections, and river bottoms in which sand is not present in any considerable proportion. Many of the soils of the prairie also abound in humus, especially when they are first broken, hence their high adaptation to the growth of millet. Muck soils are excellent when not too wet or too dry. The crop may oftentimes be grown successfully on these while yet undrained, after the saturating waters of the springtime have subsided. But on such lands the danger is imminent, in climates of ample rainfall, that the saturating waters may come again before the crop has been utilized. Medium to good crops of millet may be grown on clay soils amply supplied with moisture, but usually the growth on these is slow. Sandy soils are ill-adapted to its growth when low in plant food, and the want of adaptation in these soils increases with the increasing dryness of the climate. But the gray soils of the Rocky mountain valleys have much adaptation for millet. It is not so much needed in these areas, however, because of the wonderful adaptation of the soils for growing alfalfa.

Preparing the Soil.—In preparing the soil on

which millet is to be sown, the aim should be to have it in fine tilth, clean and moist. With stiff clay soils a fine seed bed is absolutely essential to the successful growth of the crop. When millet is the only crop grown on the land during the season, there is ample time so to till the same that all the conditions named above shall be secured before the period arrives in which to sow the millet. They are secured by stirring the surface betimes in the spring before the seed is sown. This should not be neglected, whether the land is plowed in the fall or in the early spring, for when the land is thus harrowed at intervals, weed seeds that lie near the surface will be much reduced, to the great advantage of the crop. But when millet is grown as a catch crop, the season for preparing the soil is short, hence it may be necessary to make a free use of the harrow and roller to mellow sufficiently the upturned surface of the land. When it is sown as a catch crop on a bare fallow, there will be ample time to prepare the land in good form. If the land cannot be plowed until dry weather sets in, it ought to be rolled the same day that it is plowed, to assist in retaining the moisture. But when millet is sown as a catch crop, there are instances when plowing would not be necessary. Some form of cultivation would be sufficient.

It is not customary to manure land when preparing it for millet, since it is seldom looked upon as a leading crop. There are few crops, nevertheless, that will give a more liberal response to the application of suitable manures. These are manures rich in nitrogen and in an easily available form. None are more suitable than farmyard manures in a somewhat advanced stage of decay, and incor-

porated with the surface soil. But to get much benefit from manures applied just previous to the sowing of the crop, an ample supply of moisture is needed.

Sowing.—Since millet will not grow vigorously while the weather is cool, nothing can be gained by sowing it before the arrival of settled warm weather. It should not be sown sooner than the usual season for planting corn. But it may be sown considerably later than that season when the conditions as to moisture are favorable. Since some varieties of millet will mature in two months or a little more than that from the date of putting in the seed, the sowing of millets may be continued until within sixty to seventy-five days of the usual season for early frosts. Millet in all its varieties is easily injured by frost. When grown for pasture, even a shorter period would suffice in which to grow it, since it would of necessity be eaten down before the plants had reached so advanced a stage of growth. If sown sooner than the season mentioned, the plants will start feebly, insomuch that no after conditions, however favorable they may be, can enable them to regain what they have lost in stamina. This has been demonstrated again and again by the author while growing millets.

The mode of sowing will vary with circumstances. More commonly the seed is now sown broadcast, but in some instances it is sown with a grain drill, all the tubes being in use. The latter method buries the seed more uniformly, and therefore insures a more uniform germination when moisture is deficient in the surface soil. Some kinds of grain drills cannot be made to sow millet suffi-

ciently thin unless the seed has first been mixed with some such substance as salt.

Some kinds of millet, as, for instance, the Japanese, ought rather to be sown in drills or rows with space enough between them to admit of horse cultivation. But when thus sown, the object sought is to obtain fodder rather than pasture.

When Pearl millet is grown to provide soiling food in the cured form, it should probably be sown in drills (Fig. 23). At the Minnesota University experiment station good results were obtained from growing Pearl millet in rows thirty inches apart, but more experimentation is needed with reference to this question. In the south it may be necessary to have a greater distance between the rows. When sown for pasture it is also probable that Pearl millet will prove more satisfactory if sown in rows and cultivated. It may yet be found that good results will arise from sowing it broadcast and somewhat thinly to give the plants room to tiller. But it could never be thus grown successfully unless on clean land.

When sown broadcast to provide soiling food or fodder, from two to four pecks of the seed per acre of the small varieties should prove ample. When sown to provide pasture, the amount of seed used should not be less than four pecks. More seed is required on worn land than on a new or rich soil, since in the former it does not tiller so much.

When sown in rows for cultivation, a few pounds of seed per acre will suffice. The amount will vary with the distance between the rows and the plants in the line of the row, but in no case is the quantity large. At the Minnesota University

Fig. 23. Pearl Millet Grown for Fodder.

—Minnesota University Experiment Farm.

experiment station six pounds of seed were found ample to sow one acre with Pearl millet when the rows were thirty inches apart. The seed may be sown with the ordinary press grain drill.

The covering given to millet seed ought to be light. If the roller is run over the ground before the seed is sown, it will be buried to a more uniform depth, especially when it is sown broadcast. And with soils that do not lift with the wind it will be advantageous to use the roller again soon after the seed is sown, when moisture is not present in sufficient quantity. Since millet is sown somewhat late in the season, every care should be taken to conserve ample moisture to give the crop a good start.

Cultivation.—When millet has been sown broadcast, it would not be possible to run even a light harrow over the ground after the seed has germinated without injuring some of the young plants. And yet there may be conditions when the ground is so filled with weed seeds near the surface that harrowing the crop thus would result in an increased yield of millet. The aim should be to clean the soil as far as possible on the surface before sowing the millet. But when the seed has been buried with the drill it would be advantageous to run a light harrow over the surface with the teeth much aslant, just before the young plants have appeared. The after cultivation suitable for millet that has been thus planted is about the same as that which would be suitable for corn (see Page 22). But in the case of Pearl millet cut for soiling food or even grazed down, the cultivation could be prolonged till toward the end of the season. Cultivation given just after the plants had been eaten down

and for some time subsequently, would enable them to grow up again more quickly and more vigorously than if such cultivation were not given.

Pasturing.—Any class of live stock may be grazed upon millet. Sheep will injure it less through treading than other animals. The stock may be turned in upon it as soon as the plants are sufficiently well rooted to retain their hold upon the soil while it is being grazed. This period will vary with variations in soils, but usually it will arrive some days before indications of jointing manifest themselves in the plants. When sown on summer fallows where green manure is an important consideration, the millet may be allowed to reach a more advanced stage of growth before live stock are turned in upon it. The uneaten residue may be plowed under to benefit the soil.

At the Minnesota University experiment station, Pearl millet has been grazed down, at least to some extent, by sheep. The results were not discouraging. The sheep fed upon it without hesitation, and when removed from the plot it sprang up quickly again. But it should not be allowed to become coarse and rank before turning in the sheep. Where sorghum can be grown in good form, however, it is questionable whether, under any conditions, it would be more advantageous to grow Pearl millet for pasture.

CHAPTER X.

ROOT CROPS.

Root crops can be said to be grown for forage only when the animals which consume them are allowed to feed upon them in the field where they grew. They harvest them without the aid of man, unless in so far as he regulates the freedom of access which they are given to these crops. The variety of root crops that may thus be harvested with profit is limited. On this continent the chief of these would be rutabagas, turnips and artichokes. Turnips are grown to a much greater extent than rutabagas and artichokes.

RUTABAGAS.

The term rutabaga *(Brassica campestris)* would seem to be American, in its application, at least, whatever may be said of its origin. In Britain and Canada this field root is known as the Swedish turnip. In Britain it has long been grown as forage for sheep, but it is also grown there even to a greater extent for winter feeding. When grown for forage it is allowed to mature before being grazed off. The grazing takes place in the late autumn and early winter months. In Canada it cannot be thus grazed off, unless in British Columbia, owing to the severity of the winter weather. And the same is true of nearly all parts of the United

States that are well adapted to its growth. The exceptions are along the coast line of Washington and Oregon. In the United States and Canada, therefore, the rutabaga when grown is chiefly stored in cellars and pits and fed to the live stock in winter. It makes a grand winter food for all kinds of live stock.

While the rutabaga can only be grazed off after the English method on the Pacific slope, or in certain of the mountain valleys of the south and southwest, it can also be grown as pasture for sheep in many sections of the country by broadcasting it on certain soils and grazing it off before the season of hard frost. When thus grown it is usually on new lands, frequently spoken of as "breaking." This method of growing rutabagas is not likely to become very prevalent in this country.

Distribution.—The rutabaga as a winter food for live stock has a wide range of adaptation. Like rape this plant is found at its best where the weather is moist and cool. But good crops can be grown in some of the western mountain valleys in which it cannot be said of the air that it is really moist. Western Oregon and Washington, near the sea, British Columbia and Ontario have special adaptation for rutabagas. In all the provinces of Canada east from Assiniboia they may be successfully grown, and also in all the states that border upon Canada, but not equally well in all parts of these. Rutabagas may also be grown further south, but not with the same success, unless in places with a sufficiently high altitude.

Place in the Rotation.—The rutabaga crop should always be made a cleaning crop, save when

the seed is sown broadcast. It may, therefore, with much propriety come after a succession of grain crops when the land has become weedy through growing these crops upon it thus, as it assuredly will become in time. Turnips will grow nicely in overturned sod lands when the sod is not too fresh and dense, but such lands are usually wanted for cereals because of their clean condition. A grain crop should follow the rutabaga crop, and because of the clean condition of the land, it would be well to sow grass seeds or clover seeds, or both, with the grain.

Soil.—Rutabagas are partial to a deep, moist loam soil, with enough of sand in it to keep it friable. Clay lands, light sands and muck soils are ill-adapted to growing rutabagas. In the first, they start shyly and grow slowly, and the soil is also hard to till. In the second, there is not enough food or moisture to sustain a good growth, unless much fertilizer with the proper elements in it should first be applied, and in the third, the rutabagas make too much growth of neck and top and too little growth of bulb-like root. In some instances, but not always, gravelly soils grow good crops. The gray deposit soils of the higher Rocky mountain valleys also produce good crops of rutabagas.

Preparing the Soil.—The same preparation of soil is wanted for a crop of rutabagas to be grown for forage as for a crop to be stored for winter feeding. Ordinarily the ground should be plowed deeply and in the autumn. On retentive soils the farmyard manure should then be applied and also plowed under. But in leechy soils the results will be more satisfactory if the manure can be spread on

the land, plowed or unplowed in the autumn, winter or quite early spring. Decayed manure is preferred, but when moisture can be relied on, manure in the fresh form will answer very well.

While various commercial fertilizers have been applied in growing rutabagas, none has been so applied that has given more satisfaction than animal superphosphate. Sometimes it is strewn over the land just previous to the ridging of the land for the crop, and sometimes it is drilled in with the seed. Whether the land should be plowed again in the spring, or simply disked, or otherwise cultivated, will depend upon conditions. If fresh manure has been strewn over the land, the plow will have to be used to bury it. When moisture can be relied on, there need be no hesitancy in plowing the land in the spring, even though plowed previously in the fall. But with a doubtful supply of moisture spring plowing should be avoided. In any event, the harrow cannot be used too freely in preparing the land. It is important that soil on which rutabagas are to be sown should be of fine tilth, moist and firm.

New land on which a crop of rutabagas is to be broadcasted should not be deeply plowed, as the plants will then be able to feed more readily in the decayed vegetable matter. It cannot usually be plowed too early in the spring, nor can it be made too fine by the use of the harrow and roller.

Sowing.—Rutabagas are more commonly sown in raised drills, although it may sometimes be preferable to sow them on the level, as, for instance, when the land is liable to be short of moisture during the growing season. The cultivation is more easily done when the drills are raised, but if raised

high the plants are more liable to be injured by dry weather. The raised drills can best be made with a double mold-board plow and marker attached. They may also be made with a single mold-board plow, but they can only be made thus at a serious loss of time as compared with the other system of making them. The distance between the rows varies, say, from twenty-four inches to thirty-six inches, but the average distance is about twenty-six inches.

The seed may be sown with a hand drill such as is used in a garden, when only a small quantity is to be sown, but when a large area is to be sown a drill made for the purpose of sowing field seeds is commonly used. It is drawn with one horse, sows two rows of seed at a time, and a roller attached firms the earth over the seed. But when the weather is dry and the soil is not liable to blow, it will be advantageous to use the heavy field roller after the seed has been sown.

From two to four pounds of seed are sown per acre, according to the more or less favorable conditions of soil and weather. The time for sowing will, of course, vary much with the locality. The further north, as a rule, the later should the sowing be, but the last half of May and the first half of June will pretty well cover the best season for sowing rutabagas.

When the seed is broadcasted, it is sown about the season already mentioned, but on new lands the crop will sometimes be abundant when sown later. It may be sown by hand or by the aid of a hand broadcasting machine, and at the rate of, say, three to four pounds of the seed per acre. A light har-

row sometimes, but not always, followed by a roller, may be used in covering the seed.

Cultivation.—When rutabagas are sown in drills, the horse cultivation should begin as soon as the young plants can be distinctly traced in the line of the row. The cultivation ought to be deeper at first than later, and close to the rows, but not so close as to disturb the young plants. If, at the same time, the undisturbed portion of the soil is disturbed with the hoe, but without cutting out any of the plants, the weeds can never again become so troublesome along the line of the row. The cultivation given should be frequent, and it ought to be continued as long as it can be done without breaking off any considerable proportion of the leaves of the rutabagas.

When the plants have produced four or five leaves, or when they are three to four inches high, the thinning should be done and with much dispatch. The workman stands facing the row, and with a forward and backward movement of the hoe strikes out the plants that are to be removed. The distance between the plants may be varied from six to twelve inches, but it is not common to thin the plants to a greater distance than, say, nine to ten inches. And they should be gone over a second time with the hand hoe, to perfect the thinning and also the destruction of the weeds. When rutabagas are broadcasted they are not given any cultivation.

Pasturing.—Rutabagas are more commonly grazed off by sheep. When the crop has been grown in drills the sheep are usually inclosed in hurdles, and these are moved from time to time, as required. The object of the hurdling is, first, to secure the

eating of the crop with measurable cleanness, and, second, to secure an even fertilization of the land. Sometimes additional food is given to the sheep when they are thus being grazed, as, for instance, oil cake. Such food aids in fattening the sheep more quickly and also in fertilizing the land.

Sheep may thus be grazed also on the broadcasted rutabagas when the growth is sufficiently pronounced to justify such a course. Otherwise it may prove a better way to allow them to have the freedom of the whole field when they are grazing it off.

TURNIPS.

The turnip *(Brassica rapa)* is of many varieties. They are sometimes called fall turnips, because they are more commonly fed in the autumn, whereas the Swedish varieties are more commonly fed at a later period. They are characterized by differences in the size, shape and color of the bulb, and by the habit of growth in the top. Compared with rutabagas they are flatter in shape, they grow more quickly and more above the ground and are less firm in flesh, hence they cannot be kept so long when harvested. They are more frequently grown to provide forage than rutabagas, because of their quick growing properties, and because it would not be so remunerative to harvest a crop that keeps but for a short time. Sometimes they are raised for forage by sowing the seed in drills and cultivating the plants, but more frequently they are sown for this purpose in the grain fields. They furnish forage for all farm animals, but are best adapted to sheep and swine.

Distribution.—The distribution of fall turnips is much the same as that of rutabagas (see Page 203). But fall turnips may be grown further south than the former, especially when grown late in the season.

Place in the Rotation.—The place of fall turnips in the rotation is essentially the same as that of rutabagas, when they are grown in drills and cultivated (see Page 203). Since they may be sown later in the season, where the climate is suitable, they may not infrequently be raised as a "catch crop," and after various crops, as, for instance, harvested hay, grain or early potatoes, but never in the absence of moisture.

Soil.—The soil for fall turnips is about the same as that which will be found adapted to rutabagas (see Page 204). The former will grow better, relatively, in what may be termed humus soils, hence they grow better than rutabagas in the black loam soils of the prairie.

Preparing the Soil.—The soil is usually prepared for fall turnips in the same way as for rutabagas, when the crop is given cultivation (see Page 204). But when it is thus grown as a catch crop, much attention should be given to the retention of moisture in the soil. When sown in a grain crop the preparation of the soil will be the same, of course, as that given to it in preparing it for the grain.

Sowing.—When fall turnips are sown with a view to feeding them as soiling food in the early autumn, or to harvesting the crop for autumn feeding, the directions given for sowing rutabagas will equally apply to the fall varieties (see Page 205).

To provide forage they are commonly sown with a winter grain crop, as wheat or rye, or with a spring grain crop, as wheat, oats or barley. But they should not ordinarily be sown with a grain crop that has also been sown with grass seeds, for the pasturing in the autumn would very probably prove hurtful to the young grass. With a winter crop they should be sown early, so that it will not too much shade the plants while they are young and tender. With a spring crop they should usually be sown at the same time as the grain, but may be sown later.

From one to two pounds of seed will usually prove sufficient to sow per acre. On winter grain crops the seed will have to be broadcasted. It should then be covered with a harrow. The harrowing will also be helpful to the grain when it is judiciously done. On spring grain it may be sown with the grass-seeder attachment of the grain drill when it has one, and except on stiff soils the seed should fall before the drill tubes. When the seed is thus dropped before the drill tubes it will be sufficiently covered. When it is sown just after the grain it will, in nearly all instances, be necessary to cover it with the harrow, except on lumpy or cloddy soils. On these the roller ought to be used rather than the harrow.

If the seed should be sown just when the blades of the grain begin to appear, a light harrowing at that time will not only cover the seed, but it will be helpful to the grain, that is to say, when the soil is not too wet to be harrowed.

Of the various kinds of spring grain, barley makes the best nurse crop for turnips, because of the less dense growth which it produces, and because

of its early removal. Oats is the most unsuitable as a nurse crop for reasons just the opposite.

The value of the turnip crop for forage will depend much on the character of the season and soil. In any case, the turnips are not likely to grow so as to hinder growth in the grain crop. But under favorable conditions they will come on after the crop is harvested and will produce an excellent growth of top and root. In very dry seasons they may not give any return, but in turnip growing sections it is seldom, indeed, that the crop will not be found worth more than the seed and the cost of sowing it.

Pasturing.—The sheep or other live stock that are to be pastured on the turnips may be allowed freedom of access to the pastures after the first two or three days. And if they can have access to other grass pasture, the outcome will be still further satisfactory, for the danger of an unduly lax condition of the bowels is less likely to occur. The pasturing should be completed before the weather becomes really cold, for turnips freeze much more easily than rutabagas, and when hard frozen they should not be eaten by the stock.

Observations.—1. When rape and fall turnips are thus grown together, the combination is an excellent one for sheep. The seed of each may be sown in equal quantities.

2. When fall turnips are thus sown with grain, the plowing of the land must usually be deferred until late in the season, and this is so far an objection to the system.

3. When the turnips grow to a large size, as they sometimes do, the largest are harvested and

stored away for late feeding before the grazing begins.

ARTICHOKES.

But few plants have been grown upon the farm with reference to which opinions differ so widely. Many of those who have grown the Jerusalem artichoke *(Helianthus tuberosus)* speak very highly of it, more especially as a food for swine. Others, again, look upon it as a nuisance on the farm, owing to the difficulty they have met with in cleaning the land of the plants. This difference in opinion may arise, first, from a difference in soils; second, from a difference in the methods of growing them; third, from a difference in the varieties grown; fourth, from a difference in the method of handling the crop after it has been grown; and, fifth, from a difference in handling the land when ridding it of the artichokes. That there is a place for the artichoke, especially as a forage for swine, should not any longer be questioned. The testimony sustaining this view comes from so many reputable men in various states, and from so many states, that it is not to be gainsaid.

The artichoke is a tuber which bears considerable resemblance to the potato, both in appearance and habits of growth. The tops, which frequently grow to a hight of six or eight feet, closely resemble the wild sunflower. The flowers are yellow, and seed is produced, though not so plentifully as by the sunflower. The tubers are more elongated and irregular in shape than those of the potato. They cluster more closely around the parent stem and yet they throw out runners at the same time which bear

small tubers. This it is that gives them so much power to completely occupy the land, since these small tubers, if allowed to remain in the ground, will throw up fresh plants. The tuber is less firm than that of the potato. The plant is extremely hardy, so much so that it may be allowed to remain in the ground all winter without being harvested.

This plant is grown for table use and for different kinds of live stock, to which it is variously fed. Its highest value comes from growing it for swine, and with a view to having the swine harvest the crop in the autumn or in the spring, but more especially in the autumn. The tops are sometimes fed as fodder to horses and cattle, but where other fodders grow freely, it would not be wise to set a high value on such fodder.

The strong points in favor of the artichoke crop are found, first, in the large amount of healthful food which they furnish for swine; as high as 700 bushels per acre are reported by farmers who have grown them for years, but the average yield would probably run from 300 to 400 bushels per acre, and in many instances it would be less than these amounts; second, in the fact that the swine may harvest them; third, in their immunity from injury by frost, especially while not yet harvested; fourth, in the fact that they can be planted fall and spring; and, fifth, in the number of successive crops that they will produce from one planting under certain conditions of management. As many as seven successive crops have been grown without any interruption, and under some conditions the growing of these successive crops could be further extended.

The chief objections to their growth arise,

first, from the difficulty sometimes found in ridding the land of them, and, second, from the impaction of certain lands which follows harvesting them by swine when those lands are unduly moist. These objections will be further considered elsewhere.

There are several varieties of the artichoke. But two, however, would seem to have been extensively grown on this continent. These are the common Jerusalem artichoke and the French Improved. The first is probably the hardier of the two. The second is more refined, and under favorable conditions may be expected to produce larger crops, and it is more easy of eradication.

Distribution.—But few good plants are of wider distribution than the artichoke. There are few places in the United States or Canada where the soil can be tilled in which this plant cannot be grown successfully. And yet there are certain areas with much better adaptation to its growth than other areas. As it is a very hardy plant it can be grown on high altitudes, and yet if planted sufficiently early in the season it can be grown in the warmest valleys.

In considering the highest adaptation in this plant it is necessary to bear several things in mind. These are, first, the soils and climates in which it will grow most readily; second, the soils in which it can be most easily harvested by swine; third, the soils that will receive the least injury from harvesting the crop by swine in the fall or spring; and, fourth, the duration of the season for harvesting. It is very evident, therefore, that localities with conditions for producing the largest crops in the abstract are not of necessity the best in all-round

adaptability. For instance, though it were possible to produce a larger crop of artichokes in the soils around Winnipeg than in those around Kansas City, it would not follow that it would be more profitable to grow artichokes as forage for swine in the former soils than in the latter. The climate of Winnipeg would lock the artichokes in the ground for five to six months in the year, while the climate of Kansas City would not so lock them for more than a few weeks. But for a crop to be dug and stored for winter, the former soils might be more suitable than the latter. Highest adaptation, therefore, is to be sought for in soils that will grow maximum crops, and in a climate where they may be harvested by swine during a large portion of the season which follows the maturing of the crop. And it will probably be found in the alluvial lands of the Mississippi and its tributaries, but not very near the sources of these streams.

Place in the Rotation.—Artichokes may come after any kind of a crop, but since they should be cultivated much the same as corn, they should naturally be given the place of a cleaning crop. However, because of the difficulty that is frequently found in ridding the land of artichokes, they should always be followed by some kind of cultivated crop, as corn, for instance. But a crop that could be planted later, as rape, would be even better, as a longer period would then be given for cleaning the land before sowing the crop which follows the artichokes.

When artichokes are grown as swine forage, however, it will frequently be found advantageous to grow them during successive seasons on the same

piece of land for at least a limited term of years. When thus grown, replanting will not be necessary, and the labor of cleaning out the artichokes for the next crop in the rotation will be lessened in proportion as the term of growing the successive crops of artichokes is extended.

Soil.—A soil that will grow artichokes in excellent form should be deep, moist, friable, free from stagnant water at all seasons of the year, and well filled with vegetable matter. Black loams, therefore, and muck soils will be found very suitable. Good crops may be grown on sandy soils in moist seasons, providing they have first been properly enriched, but not when the opposite conditions prevail. The sandy and alluvial soils of the Rocky mountain region should grow excellent artichokes when irrigated. Strong and even hard clays may produce good crops, but artichokes should not be grown on such lands as forage, since the swine cannot dig them except at the expenditure of too much labor, and if they are allowed to search for them in clay land when it is wet, it would become so impacted that for a time subsequent to such foraging it would be impossible to cultivate it without great labor.

Preparing the Soil.—In preparing the land for artichokes, much will depend upon the season of the year when the sets are to be planted. When planted late in the fall it is not absolutely necessary to have the soil in tilth as fine as for spring planting. When planted in the spring the tilth should be fine. In the moist states of the east the aim should be to have the soil lie loosely upon itself, but in the more dry prairie soils the aim should be to have the land

firm. In either case, the plowing should be deep. Manure may be plowed in or put upon the surface before planting the crop or after planting, according to conditions.

Sowing or Planting. — Artichokes may be planted in the fall or in the spring. When planted in the fall, late planting will usually be found preferable, as then the winter frosts will not cut off the young growth. This would be seriously injurious to the plants when young. But in the spring the planting should be early, considerably earlier than would be safe in planting potatoes. When planted in the fall, whole tubers ought to be used. When planted in the spring, cut sets will answer, though perhaps not quite so well as medium-sized tubers planted whole. Deep planting is preferable to shallow planting, since it makes possible more thorough cultivation before the plants are up, and it further removes the feeding ground of the roots from the influences of surface evaporation.

The planting may be done, first, by the ordinary potato planter, or, second, by making furrows or trenches with the plow at suitable distances and dropping the artichokes in these by hand. These furrows will vary from three to six inches in depth, according to conditions. The trenches may be covered with the plow or the harrow, according to attendant circumstances. In slough lands that are dry enough for artichokes it may very well serve the purpose to drop the artichokes in certain of the furrows while the land is being plowed.

The distance between the rows and also between the plants in the row varies, but the rows should not be nearer to each other than three feet, and the

plants in the line of the row should not be nearer than eighteen inches. A greater distance between the plants will probably provide the largest yields, unless in soils deficient in fertility.

Cultivation.—The first year the cultivation of artichokes should be thorough during all the early part of the season. The first harrowing should be given a few days after the artichokes are planted. The subsequent harrowings should ordinarily be from two to four in number, and they ought to be made before the plants reach the hight of, say, six inches. The horse cultivation should then begin. It ought to be given frequently, and it is important that it shall be shallow so as not to break the horizontal rootlets of the plants.

When the crop is to be grown during successive years on the same land without replanting, the soil should be carefully harrowed, or otherwise leveled, every spring before other cultivation is attempted. As soon as the young plants appear, they should be all cut out with the cultivator, except such as are allowed to remain in narrow strips about three feet apart to form the rows. The cultivator should then be made to cross the rows likewise, but in the second instance the rows may be left somewhat closer. The artichokes will then grow at the corners of squares, or of rectangles, hence the cultivator may be used so as to run in various directions. The harrow will probably be the next implement to use, that the weeds around the plants may be killed. Horse cultivation should then follow, as previously described.

Pasturing or Foraging.—The management of the foraging of this crop will vary with variations in

climate. In any climate, ordinarily, it ought to begin as soon as the crop has matured for the season. But in cool climates it is especially important that it shall begin early, for as soon as the ground freezes the foraging must cease until the following spring. It may then be resumed if the ground is not too moist, but generally the season for spring foraging is very brief, as the value of the tubers for feeding is much impaired after they begin to grow.

When swine are foraging on artichokes, they may be given access to them at will. But when practicable it will also be better to allow them the option of feeding on other pasture, on the principle that a variety of suitable foods is beneficial. Whether they should be given additional grain food will depend upon the age of the pigs and the object sought in feeding them. Young pigs should be given additional grain food, as shorts, for instance, but brood sows will not usually require a grain portion. The exercise which the sows get in foraging for the artichokes is very beneficial to them, and more especially when they are pregnant. Pigs that are being made ready for fattening will do well on artichokes supplemented with grain, especially corn. But swine that are being fattened should not be required to labor so hard for their food. However, when they have been reared chiefly on a corn diet, such exercise, when not excessive, will tend to keep them in a healthy condition.

Observations.—1. When artichokes are grown for successive years on the same land, well rotted manure may be advantageously applied to them by incorporating the manure with the soil while the land is being leveled in the spring.

2. In preparing the soil for a crop which is to come after the artichokes, the plowing of the land should be deferred in the spring until the more advanced of the volunteer plants have reached the hight of twelve inches or more. If the plowing is done with due care, many of the artichokes that thus sprouted will die. The cultivation given to the crop that is then planted, along with some hand hoeing, should destroy the artichokes in a single season.

3. Owing to the great yield that artichokes are capable of producing, it is not necessary to plant a large area unless where the herd of swine kept is numerically large.

CHAPTER XI.

MISCELLANEOUS PLANTS.

The plants which have been discussed in the preceding chapters have all been found more or less useful in providing pasture or forage for domestic animals, although experience in growing some of them for such a purpose has not been at all extensive. In addition to these there are a number of plants, the value of which in providing pasture has not been proved on this continent at all, or if so proved, it has been in only limited areas, although elsewhere, as in some parts of Europe, for instance, they have been found more or less valuable in providing pasture. Prominent among these are the following: The flat pea, sweet clover, yellow clover, Japan clover, sainfoin, spurry, kale, white mustard, lupines, sacaline, peanuts, the velvet bean, beggar's ticks and Australian saltbush. Further experience is required in testing these plants on our continent before it would be possible to pronounce with even approximate correctness as to their value in providing pasture or other food for live stock. But they should be tested by the experiment stations rather than by the farmers, since all experimentation is more or less costly. This is a work which the experiment stations are always ready and willing to take up, and carry on until tangible results are obtained. One object sought in referring to them here is to call attention to the

fact that their value in providing forage has not yet been determined.

THE FLAT PEA.

The flat pea *(Lathyrus sylvestris)* is a legume. It is perennial in its habit of growth. In appearance it bears no little resemblance to the "grass pea," which has been grown for many years in some sections of the United States and Canada. The seed is tardy in germinating. The plants grow slowly for a time. The first year the growth varies from six to twenty-four inches, according to the nature of the soil, climate and season. The next year and subsequently they should furnish from one to two or three cuttings, according to the conditions. Complaints have been made that the plant is a shy bearer of seed.

The flat pea is certainly a hardy plant. When once established it will endure much drouth. At the Ontario experiment station at Guelph, it withstood the cold of winter without apparent injury. It has also lived through several winters in the state of Michigan. At the University experiment station of Minnesota, however, it has in some instances succumbed the first winter when planted in exposed situations. As to its duration, claims have been made for it that sound extravagant. It has been affirmed that the plants will live indefinitely, or at least from fifty to sixty years. At the Michigan experiment station, 41,185 pounds of green food per acre were obtained from two cuttings in one year. But it was found that the stock consumed the food with reluctance, whether fed in the green or the dry

state. Of course if this experience should prove general there will be no place for the plant in the agriculture of this country, but conclusions should not be drawn hastily with reference to the palatability of fodder plants when but newly introduced. The taste of domestic animals is quite susceptible of cultivation. The limited quantities grown by the author in Ontario were apparently relished by the bovines to which they were fed in the green form.

It is probable, however, that the flat pea will not become greatly popular in areas well adapted to the growth of clover, alfalfa and vetches. Nor is it likely soon to find a prominent place in regions where the rainfall is sufficient in a normal season to meet the needs of ordinary farm crops. If there is a place for this plant in the agriculture of the United States, it is likely to be found in the dry areas of the southwest and on lands in these which cannot be irrigated. And it is also probable that it will be found more valuable, relatively, in providing pasture for sheep than in growing soiling food. But experience with reference to pasturing the flat pea would seem to be wholly wanting in America.

Because of the slow growth of the seeds of the flat pea, it has been recommended to start the seed under favored conditions, as in a bed prepared for the purpose, and then to transplant into rows where the plants are to remain. Such a process, however, would involve so much labor that it is not likely ever to come into general favor. Nor does it seem necessary, where the preparation of the ground for the seed has been given sufficient care.

The soil for this plant ought to be porous and free from stagnant water in both soil and subsoil,

since it feeds deeply. It should be so prepared that the weeds will not be superabundant while the plants are yet young. The seed should be sown in rows from two and one-half to three feet distant. The ground must be kept free from weeds the first season by using the cultivator and also the hoe. And it is recommended that cultivation should also be given during subsequent seasons. But more experience is required before pronouncing definitely on the necessity for such cultivation, and also on the benefits accruing therefrom. There are good reasons for continuing experimentation with this plant, especially in the southwest and south.

SWEET CLOVER.

Sweet clover *(Melilotus alba)* is so named, doubtless, from the fragrance of the odor which characterizes it. It is also frequently called Bokhara clover. The two species, *Melilotus alba*, and yellow sweet clover *(Melilotus officinalis)* are closely allied, but the blossom of the former is light colored, while that of the latter is yellow.

Sweet clover is a strong, vigorous growing biennial. It is branched and upright in its habit of growth. It is one of the most hardy plants of the clover family. When once firmly rooted it has great power to withstand drouth and heat, and it can also endure low temperatures. Being a ravenous feeder it is able to maintain itself in soils too poor to sustain other species of the clover family. The writer has succeeded in growing sweet clover on a vacant lot in St. Paul, from which several feet of the surface soil had been removed, insomuch that

only sand and gravel remained. Moreover, it is a legume, and one which has much power to renovate soils. A plant, therefore, which is possessed of such powers should not be looked upon as worthless. That it is so is the popular idea. It has even been looked upon as a weed, and some countries and states have included sweet clover in the list of proscribed noxious weeds.

But sweet clover has been grown to some extent to provide hay for live stock in the cured form, and also to provide pasture. And it has been grown to furnish food for bees when it is in bloom. It has been grown for all these uses in the south, more particularly in the states of the lower Mississippi basin. For providing hay it is not very suitable, for the reasons, first, that it is woody and coarse in character; second, that it is difficult to cure; and, third, that it is not much relished by live stock. They do not care to eat it when they can get a sufficiency of other food, as corn, sorghum, or other clovers. As a food for bees it is excellent, and if a part of the plot or field is cut before coming into bloom, the season of bloom will be much prolonged. It is also sown along the sloping embankments and the sides of railway cuttings. The object sought is to prevent these from washing, and it has proved highly serviceable for the purpose.

Sweet clover has not been much grown for pasture, but for such a use it may yet prove to be of value. When sheep have access to a variety of grasses they will probably pass sweet clover by, even when it is young and tender. But if confined to such a pasture when it first begins to grow they would soon begin to crop it down. To force ani-

mals thus to eat food under constraint is not good for them, but thus it is that in some instances sheep have to be confined on rape and forced to eat it through sheer hunger. In a short time they become very fond of the rape. So likewise they may be taught to eat sweet clover. Of course where other and better kinds of clover will grow, it would not be wise to trouble with sweet clover. But in the semi-arid belt east of the Rocky mountains, and in the poor, sandy soils of the south, it may yet be found that an important mission awaits this plant, first, in growing a crop that will renovate the soil when plowed under and increase its power to hold moisture; second, in furnishing food for bees; and, third, in providing pasture. Hay should be sought from it the first year rather than the second.

Sweet clover can only be sown in the spring or summer in very cold latitudes, but in those that are mild it can be sown in the autumn or spring, preferably the former. Usually not less than fifteen pounds of the seed is sown to the acre. In the south it is frequently sown on the surface of stubble land after the crop has been harvested, and when thus sown it is simply covered by the harrow. If sweet clover is kept from blossoming, the land will soon be freed from it when it is so desired. Although sweet clover seeds profusely, the high price of the seed at the present time stands much in the way of extending its growth.

YELLOW CLOVER.

Yellow clover *(Medicago lupulina)* is sometimes called black medic. At other times it is spoken of

as trefoil, but this term is not sufficiently specific. Nor is it to be confounded with hop clover *(Trifolium procumbens)*, although there is much of resemblance between the two plants.

Yellow clover is perennial and recumbent in its habit of growth. It does not make sufficient growth to render it of much value for hay. But as a pasture plant it is, to some extent at least, deserving of a place in our agriculture. It bears seed profusely, and as the season of bloom is prolonged when it is pastured, this plant has much power to re-seed itself and therefore to maintain its hold upon land where it has been grown.

Yellow clover has special adaptation for soils well supplied with lime. On such soils it has in some localities almost assumed the character of a weed. But this can only happen in rainy climates. It will also grow in gravelly soils where some of the other varieties of clover would fail. The author has met with it growing in great luxuriance in a semi-wild condition on the coast of Puget Sound. It also grows freely in several of the northern states and of the provinces of the Dominion of Canada that lie eastward from Lake Huron. And it is probable that it may be grown with more or less success in all, or nearly all, the tillable portions of the United States and Canada.

Where other and superior kinds of clover will grow freely, it is not necessary to give much attention to yellow clover. But in permanent pastures, even among superior sorts, it has a place, since it comes on early in the season and grows vigorously, and it is fine and leafy when young. But as summer advances it becomes woody and ceases to grow.

As a pasture plant it is not the equal of white clover *(Trifolium repens)*, but it may be able to grow in some situations where white clover will not succeed.

The seed of yellow clover is relatively cheap, hence to add one or two pounds of the seed per acre to a mixture to be sown for permanent pasture will not add much to the whole cost of the seed. When sown alone, from three to five pounds of seed would probably be ample. But it should only be thus sown to provide seed. The seed may be sown by hand or with some form of hand seeder, and covered with a light harrow or a roller, according to the character of the soil. When not sown to provide seed it ought to be made a part of a grass mixture rather than the sole crop. In such instances one to two pounds of seed per acre should suffice.

JAPAN CLOVER.

Japan clover *(Lespedeza striata)* is growing in favor in the south. It is said to have been first introduced into the United States from China, and has become prominent since the time of the civil war. It would seem to be adapted only to southern conditions and will probably never have a place among the pasture crops of the northern half of the United States or in Canada. It has been grown with no little success in all, or nearly all, the Gulf states.

Japan clover is a low growing annual. On lands low in fertility it can only grow to the hight of a few inches, but on rich soils otherwise suitable it sometimes reaches the hight of sixteen inches or more. The leaves are triplicate. The flowers are numerous and blue in color. The plants produce

seed abundantly. On lands not too foul with weeds, it is able to maintain itself for years by the process of self-seeding, if not kept grazed too closely or harvested too early in the season. But if harvesting is deferred until some of the seed scatters, the feeding value of the hay will be lessened.

As Japan clover is a legume, its growth is of course beneficial to the land. It is useful as a pasture crop and also in producing hay. The taste resembles that of white clover, and it is relished by live stock. Although it responds to cultivation it grows in a wild state in some parts of Louisiana. It starts late in the season and has no little power to withstand the influences of dry weather. It is what may be termed a summer or an autumn crop.

In preparing the soil for Japan clover it ought to be given sufficient cultivation to clean it on and near the surface, otherwise on rich lands the weeds will greatly injure the growth of the clover. On poor land that is foul, the clover will better resist the encroachments of weeds than on rich land thus infested. It has some adaptation for hard, dry, clay soils, but will grow better on soils where the conditions are more favorable. As this plant does not grow until the weather becomes warm, nothing can be gained by sowing it earlier. For pasture or for hay, twelve to fifteen pounds of seed are sown per acre. Since it is a summer rather than a spring plant, the pasture which it furnishes is seasonable.

SAINFOIN.

Sainfoin *(Onobrychis sativa)* is sometimes called esparcette or asperset. The German spelling

is esparsette. It is a legume of the clover family, which has special adaptation for limestone and dry, chalky soils. It has been grown in the south of England, in France and in other countries of Europe for several centuries. It has been made to render the best of service in providing pasture for sheep and soiling food and fodder for cattle and horses. In the south of England it is considered indispensable on many sheep farms, notwithstanding the excellence of the turnip crops that are grown on these.

Sainfoin is a vigorous growing plant. It is branched and spreading. Its flowers are numerous and of a showy red color. It will frequently produce two or more cuttings of hay or of seed, and several cuttings of soiling food, in a single season. But it is seldom advisable to seek two crops of seed in one season, since the first crop does not yield nearly so well as the second. It is better practice to cut the first crop for hay, to use it as soiling food, or to pasture it, as in growing the seed of common red clover. This plant will retain its hold upon the soil for several years. But other grasses are much prone to crowd it out as it becomes older. In some instances it is only grown for one or two seasons, but usually the seed is too costly to admit of thus sowing sainfoin.

In Europe it is common to sow the seed while yet in the seed sac, but it is not always sown thus. In the rough form from four to five bushels of seed per acre are used. When harvesting the seed much care must be exercised in handling the crop or much of the seed will be lost. It should not be handled in the heat of the day. And when being made into

hay the same care is necessary or many of the leaves will be lost. Much care must also be given the seed, or it will heat and spoil. Inattention to this matter is largely responsible for the many failures to secure a good stand of plants. But it would also seem to be true that the seed loses its germinating power more quickly than the seed of many other legumes. Sainfoin, like clover, is very beneficial to the soils upon which it is grown.

But little attention has been given heretofore to the growing of sainfoin in this country. It is scarcely mentioned in the reports of the experiment stations. And yet it is not improbable that it may be turned to excellent account in furnishing food for live stock in some sections of the republic. The author has traced its successful growth in the vicinity of Deer Lodge, Montana. The grower prized it on account of the early season at which it furnished food. At the Ontario experiment station, at Guelph, the attempts to grow it were not encouraging. Unquestionably it ought to have a milder climate. It is probable that it will grow admirably in the coast states between the mountains and the sea. It ought to do well in the mountain valleys from central Montana southward. And there may be localities in the balmy Gulf states favorable to the growth of sainfoin. Beyond all question, this plant is worthy of more careful experiment than it has hitherto received.

But why should the attempt be made to grow sainfoin where we can grow alfalfa, or clover? For the reason that there is less danger from bloating with the animals pastured on sainfoin. At least it has been so claimed. If this be true it invests sain-

foin with a peculiar interest to those who grow sheep. A plant that will grow equally well, or nearly as well, as alfalfa where sheep are kept numerously, and that could be pastured by them without danger from bloating, would be a great boon to the owners of sheep, since they cannot be safely pastured on alfalfa.

The preparation of the land for sainfoin is substantially the same as for alfalfa (see Page 97). The seed in the rough form is commonly sown by hand, but there would seem to be no good reason why it should not be deposited with the grain drill. It may be sown with or without a nurse crop, according to the conditions.

SPURRY.

Spurry *(Spergula arvensis)* is looked upon as a weed in some of the light soils of Great Britain. This, at least, was true of it at one time. In Scotland it was called yarr, and in Norfolk, pickpurse. In other countries of Europe, as, for instance, Denmark, Holland, Belgium, and some parts of Germany and Russia, spurry is highly esteemed as a pasture for cattle and sheep, and it is also valued for its fodder. It has been found specially valuable as a pasture for sheep and milch cows. Animals pastured on it are not liable to injury from bloat. Though they may not take kindly to the pasture at the first, they soon get exceedingly fond of it, both in the green and cured form. It is also claimed that it has good milk producing and fattening properties.

Spurry is a tiny-like plant which grows from a few inches to fully twenty inches in hight, according to the soil. The variety that has come into the

market under the name of "giant spurry" is simply the ordinary spurry. It is not capable of making a stronger growth than ordinary spurry, as the name would indicate. The stems of spurry are numerous and exceedingly branched. They are fine in character, and they so interlace as to make it difficult to walk through the crop in an advanced stage of growth without tripping. The flowers are very many, are not more than one-eighth of an inch in diameter and are white in color. The seeds are small. They are contained in small seed heads resembling those of flax, but not more than half as large. They vary from dark brown to black in color. The plants seed profusely. On some soils the yield of fodder has been estimated as equal to that of clover, but ordinarily it would not be so much.

The plant has special adaptation for light, sandy soils, and for climates that are moist. Whether it will be given a place of much prominence in our agriculture has yet to be determined. On productive soils it is not likely to come into general favor, since other plants equally nutritious will give greater yields. But on light, sandy soils low in fertility, it should render valuable service where moisture is sufficiently abundant. But few of the agricultural experiment station reports even mention spurry, hence testimony regarding its adaptation to our conditions is almost entirely wanting. It has been grown, however, on the light and infertile sands of the experiment sub-station at Grayling, Michigan, since 1888, and the reports concerning it are encouraging. When plowed under in the green form it has been found specially helpful in giving

"body" to the light, sandy land and in otherwise fitting it to grow successfully crops of clover and grain. At the Minnesota University experiment station, spurry has not proved altogether satisfactory thus far. The growth secured has not been sufficient to make it a competitor with some other crops.

Spurry should be sown more as a catch crop than as a regular crop in the rotation. It should be ready to pasture or to plow under in from six to eight weeks from the date of sowing, providing it is not sown before the weather has become warm. Where there is moisture enough to insure germination, spurry can be sown after a grain crop, and simply covered with a harrow. On the bare fallow it would also seem to have a place. When grown as a green manure or as a pasture for sheep, two crops a year may be secured, and in some climates three. This crop, therefore, would seem worthy of attention on the part of our agriculturists, more especially on "pine lands" where the soil is sandy and poor and where the climate is moist in character.

Since spurry is best adapted to light, sandy lands, but little labor is necessary in preparing the soil. The seed should fall on a smooth, impacted and fine surface, and it may be sown and covered in the same way as clover seed. As the seed is small, a light harrow will give a sufficient covering. From six to eight quarts of seed are sown per acre to provide pasture, fodder or green manure. But a less quantity will suffice to produce a seed crop in good form. It is ready to cut for hay after the seed has formed and before it is ripe. The seed may be har-

vested and threshed like clover seed. When grown for the seed, a sufficient quantity is likely to shatter out to produce a crop the next year, by simply running the harrow over the land in the early spring.

Spurry has been called "the clover of light, sandy soils," because of its value in improving the same, both in texture and fertility, when grown as a green manure. It should be turned under with a light furrow that the plant food may be kept near the surface. If some of the seed is allowed to ripen before the crop is thus buried, another crop of spurry will grow above the decaying plants without the necessity of sowing any more seed. Under some conditions it is possible to plow under three crops of spurry in one season.

KALE.

Kale is a variety of *Brassica oleracea,* the species of cruciferous plants to which cabbage, cauliflower and Brussels sprouts belong. Ordinarily, it means any variety of headless cabbage which produces curled and crinkled leaves, but in some varieties the leaves are smooth. In some of its varieties it is grown in kitchen gardens for its leaves. These are variously cooked, as for greens, for potherbs, or as a component in making some kinds of soup. In certain parts of Virginia, much kale is grown and shipped to the northern markets in winter. In Great Britain some varieties of kale are grown to provide green food for sheep and lambs at certain seasons of the year, but more especially in the early spring. One variety is very much branched. It is popularly spoken of as "thousand-

headed kale." It produces fine and tender herbage, which is greatly relished by lambs, and is also very suitable for them. Kale bears no little resemblance to rape in what may be termed its general habit of growth. It produces only leaves and stems the first season, and in these its virtue consists as a pasture or as a soiling food. The common varieties of kale do not seem so well adapted as rape to furnish either, since, on many soils at least, they do not grow so quickly, nor do they produce so much in bulk.

The trial plots grown at the Minnesota University experiment station proved fairly satisfactory. When sown late in May, the plants were ready for being fed off by the middle of July. Those not used as food at that season lost what may be termed their bloom, while the hot weather lasted, but when the autumn rains began to fall, they measurably revived and retained their greenness until the approach of winter.

Kale is adapted to the same kinds of soil as rape (see Page 152). The preparation of the soil is also the same. But it will probably be found that kale is not so well adapted to broadcast sowing as rape, since it is not so vigorous a grower. When sown in rows these should not be closer than twenty-four inches. The directions given for sowing rape in rows will apply equally to kale. From one to two pounds of seed will be sufficient to sow an acre.

The wisdom of sowing such varieties of kale to provide pasture as are usually grown in our gardens is at least to be questioned. Dwarf Essex rape will probably better serve the end sought. But the variety grown in Great Britain as "thousand-headed kale" may yet be given an important place in our list

of pasture plants. On the coast of the Atlantic there should be a place for this plant, and also on the coast of the Pacific. But when it is to be used as a spring pasture, it can only be grown in mild latitudes. It should certainly be given careful experimentation in the areas referred to.

MUSTARD.

The only species of mustard that have been extensively grown as field crops are known as black and white mustard, respectively. Black mustard *(Brassica nigra)* is known also as brown or red mustard. Formerly it was extensively grown for the seed in Great Britain and certain other countries of the continent of Europe, and in some localities it is still looked upon as a valuable crop. It has been objected to as a regular rotation crop, first, because of its exhaustiveness on the land; second, because of the liability to damage through discoloration of the seed, as by rain when it is being harvested, and, third, from the danger that plants from the seed will spring up and make trouble in succeeding crops.

White mustard *(Brassica alba)* is distinguished from the black by its stems being covered with rough leaves and by the pods terminating in a broad two-edged beak. The seeds are of a pale yellow color. This kind is also frequently grown for the seed. A good crop in Great Britain yields from thirty to forty bushels per acre. It is sometimes grown for being plowed under. It is excellent for such a use because of its rapid growth and bulky character, because of the large proportion of the food which it gathers from the air, and because of the ameliorating

influence which it exerts upon the soil. But it is grown even more frequently as a catch crop to provide pasture for sheep, and more especially in seasons when turnips have failed. In the climate of England it is ready for being pastured or plowed under at eight weeks from the date of sowing, when it is not sown sooner than the last half of July nor later than the end of August. In the Mississippi basin, and indeed in the major portion of the United States, it should grow even more quickly, because of the higher mean summer temperature. Some day, therefore, there ought to be an extensive place for this plant in our system of agriculture. There is ample time to grow it after many crops have been harvested. On fallow lands and especially on those of the prairie there should be a place for white mustard. When grown on these it could be wholly grazed off by sheep. If too abundant to admit of its being all eaten, after the depasturing the residue could be plowed under with great advantage to the succeeding crop or crops.

White mustard will probably grow in any of the tillable portions of Canada or the United States where the land is supplied with a sufficiency of moisture, whether obtained from a natural or an artificial source. On the valley soils amid the Rocky mountains it should produce large yields of seed, because of their richness in phosphoric acid. The high price of the seed may interfere with the extensive growth of this plant at the present time, but it would be easy indeed for the farmer to grow his own seed. The author grew it to some extent at the Ontario government experiment farm, at Guelph, where it yielded seed profusely. Nor is there any real diffi-

culty in ridding the land of the plant where seed has been grown, as in the case of black mustard.

When grown as pasture or as green manure, the seed may be broadcasted on nicely pulverized land and covered with the harrow. From ten to fifteen pounds of seed would be ample to sow an acre, and on soils rich and in a good condition of tilth, probably half that amount would suffice. The seed should not be sown until danger from frost is past, as mustard plants are much susceptible to injury from frosts at any stage in their growth. In warm weather they grow with great rapidity in light soils.

When mustard is grown for sheep pasture, it may be sown alone or in conjunction with rape. It is believed that when sheep are pastured on a mixed crop of rape and mustard, they are less liable to take injury from bloat than when pastured on rape alone. In other words, the mustard would seem to lessen the hazard. One chief objection to mixing the seeds of mustard and rape to produce such a crop arises from the greater quickness with which the mustard grows. It is ready for being pastured sooner than the rape, hence by the time the rape is ready, the mustard has become in a sense woody. The leaves and pods will be eaten, however, though the stems may be rejected. This difficulty may be obviated, in part at least, by sowing the mustard in one or more portions of the pasture later than the rape.

Mustard alone is not a sufficient pasture for sheep. When feeding on it they should also have access to grass or other pasture. Although it furnishes a healthful food for them, it may lead to purging when they are first turned in upon it if allowed to pasture upon it at will, and the danger is all the

greater if they have previously been accustomed to dry pasture only. It is ready for being grazed off when the plants are forming flower buds. And it should be eaten down quickly because of the shortness of the period which it requires to mature.

THE LUPINE.

There are many species of the lupine genus. It belongs to the Pulse or *Leguminosae* family. Several species were known to the ancients and cultivated by them as food for man and beast. In the United States the species are numerous, and they are found chiefly west of the Rocky mountains. Their agricultural value does not appear as yet to have been determined. In the eastern states there are several species, with flowers ranging from blue to white in color, and some of these are cultivated in gardens.

Of the sorts now grown in Europe, the white lupine *(Lupinus albus)* is by far the most valuable. It is still extensively cultivated in Italy, Sicily, and other Mediterranean countries for forage, for plowing in to enrich the land and for its round, flat seeds, which form an article of food. The cultivation of the lupine in Portugal has proved a great national blessing, and has regenerated large tracts of wornout land. In Germany and other countries of western Europe, great use is made of this plant in bringing fertility to poor, sandy lands too poor to grow other food crops profitably, until so renewed.

The white lupine is an annual. It derives its name from *lupus*, a wolf, in allusion to its voracious qualities, that is to say, to the greedy way in which

it gathers plant food from the soil. Its long roots strike deeply into the same, and appropriate to themselves whatever they find there capable of nourishing them, and when again plowed under they leave the food thus gathered near the surface, and in a readily available form, so that it can be easily taken up by more shallow rooted plants. The strength of the plant will of course depend upon such conditions as climate, soil and soil constituents. The young plants are readily eaten by sheep, and some of the other domestic animals. At least, so it is claimed by many authorities. The author has only grown lupines to a limited extent, and not with results highly encouraging. The tests were made in the province of Ontario. In central Michigan, several varieties, after numerous trials, have uniformly made a slow, sickly growth. The seeds are not looked upon as being of great commercial value. The greatest value of the lupine arises from the enrichment which it brings to poor soils, as light sands, gravels and thin clays.

The white lupine has not been much grown in this country, hence information regarding it is meager. The localities, therefore, in which it is likely to flourish cannot now be given with precision. But there would seem to be no good reasons why it should not be made to render valuable service in providing pasture for sheep and in bringing fertility to poor, sandy and gravelly soils in such portions of the United States and Canada as are favored with a moist summer climate. Such are certain of the soils of New England, northern Michigan and Wisconsin and the Atlantic provinces of Canada, and such is the climate in these localities. The same is

also measurably true of portions of the Gulf states, and lupines may also have a mission in renovating worn soils in the same areas. The agricultural experiment stations can soon determine this question.

SACALINE.

Sacaline *(Polygonum Sachalinense)* has been given more attention by experimenters in our agricultural colleges than many other plants more deserving of investigation. In field experiments at the experiment stations, the claims of some plants for investigation would seem to come at high tide, while the claims of some other plants rich in promise have been but little heeded. The experiments thus made with sacaline, however, have been valuable in determining so quickly the comparative worthlessness of sacaline as a forage plant or as a fodder plant in the United States. In this finding the reports are practically unanimous.

Only two or three years ago certain of the seedsmen were extravagant in their recommendations of sacaline. They claimed that it was a most vigorous grower, that it would flourish in almost any kind of soil, wet or dry, loamy or tenacious, light or heavy, rich or poor; that it would furnish several cuttings a year; that it was highly nutritious, and that live stock were fond of it. No one of these claims has been verified in any considerable degree by the reports that have been published regarding it by the various experiment stations on this continent. At the Minnesota University experiment station, the growth made in any one season has been inconsiderable. The plants soon became woody, and the live stock could not be induced to eat it.

Sacaline is said to have come from the island of Saghalin or Sakhalin, in the sea of Okhotsk, between Japan and Siberia. It is shrub-like and leafy in its habit of growth. It is more commonly propagated by means of root cuttings. It is of more than one variety, and this fact may be measurably responsible for the almost universal condemnation given to it in America. In some parts of Europe it has found no little favor. In the meantime the farmers of this continent will do well to leave sacaline in the hands of the agricultural experiment stations.

THE PEANUT.

The peanut *(Arachis hypogaea)* is variously known by such names as goober, earth nut, ground nut, pindar, ground pea, jar nut, manilla nut and monkey nut. It is an annual and belongs to the Pulse family. The habit of the growth is trailing The branches are numerous and likewise the leaves. The latter bear no little resemblance to clover leaves. After blossoming, the little pods bend down and thrust themselves into the ground. The cultivation adopted still further aids in burying the fruit of this plant. It matures, therefore, below the surface of the ground. Within the shell or kernel one, two or three irregularly ovoid-shaped seeds are produced.

The peanut is a tropical or sub-tropical plant and is adapted only to warm climates. Botanists are not agreed as to whether it is a native of Africa or America. For a long time it has been much grown in America, Africa, India, China, and the islands of the Malayan archipelago. It can be grown in fairly good form in all the states of the

Union south of the 40th parallel, that is to say, south of the latitude of Indianapolis.

This plant has hitherto been grown chiefly as an article of commerce. It is cultivated much the same as Indian corn. The fruit is sold somewhat extensively as food in all cities north and south, and it is made into an oil that is used as a lubricant and also for lighting.

In some of the southern states it has been grown as a food for live stock and more especially as a forage for swine. Since it is adapted to sandy land it may be grown on large areas in the southern states. The yield in some instances is not much less than forty bushels per acre, but ordinarily it is considerably less than that amount. Whether it shall come to be generally grown as a food for swine may depend somewhat on the market values of the fruit. Swine are fond of the nuts, and when thus fed the labor of digging is avoided.

THE VELVET BEAN.

The velvet bean *(Dolichos multiflorus)* is a plant which has only recently been brought before the American public. It has been grown for several years in Florida, but rather as a trellis shade than as a food plant or a fertilizer. It is said to have been imported into Florida from Brazil, and into the test gardens of some seedsmen from Japan. Its precise value to the United States has yet to be determined, although there can be but little question that as a food plant and also as a source of fertility it may yet be made to bestow much benefit on the more southern of the Atlantic states and also on

those which border on the Gulf of Mexico. But present indications would seem to point to the conclusion that it is not likely to be extensively grown much further north than the areas named, since it requires a comparatively long season to mature its growth.

The velvet bean is of a trailing habit of growth. The vines run out from the hills in every direction and to the distance of ten to twenty feet. It commences to fruit near the hill, and thence along the whole length of the vine at intervals. The pods appear in clusters and they contain each from three to five beans. They are thick and leathery and of a brown color. The surface of the pod is velvety in character, hence the name given to the plant.

The velvet bean has highest adaptation for sandy soils, and on these its power to grow is so marked that it will push ahead where rye will grow but feebly. Since it requires a long season for perfecting its growth, it should be planted reasonably early in the spring. Much has yet to be learned about the best methods of growing it, but some experimenters favor planting in hills in squares four feet distant. Other growers recommend planting at a greater distance. From three to five seeds are sufficient for a hill. Careful cultivation should then be given in due time and this ought to be continued as long as the work can be done without injury to the extending vines.

It is claimed that stock eat the velvet bean with avidity when green or cured and that it makes a valuable hay. But these claims should be received with some reserve until they have been

further attested. It must surely be somewhat difficult to harvest a plant for hay which grows as the velvet bean does. But there can be but little doubt as to its unusual power to grow even in poor soils and to bring fertility to them. Its power to produce root tubercles is marked, and the mass of foliage with which it covers the soil is very great, hence when this leguminous plant is buried with the plow in the green form it not only adds much to the fertility of the land, but it greatly increases the power of the same to hold moisture, at least for a time.

BEGGAR'S TICKS.

Beggar's ticks *(Desmodium tortuosum)*, sometimes called beggar weed, is an annual, and it is, moreover, a legume. It is a vigorous grower and it has much power to grow on poor soils. During recent years it has come into considerable favor in Florida and some other parts of the south as a hay producing plant, and since it grows again when eaten off or cut down and is also relished by live stock, it should have considerable merit as a pasture plant. At the Minnesota University experiment farm, plants from seed sown in May were coming into flower in September. The plants are sturdy and branching and are somewhat coarse because of the space given them to branch out.

It is at least questionable if as good results will be obtained from growing beggar's ticks for pasture as from growing cowpeas where the latter do well, but this question does not appear to have been settled as yet. Since it is able to fight its own battle in the

companionship of many noxious weeds and since it is an enricher of the soil, its merits are not to be overlooked.

The very best methods of growing it do not as yet appear to have been wrought out, but it can be grown by sowing the seed broadcast or in drills and cultivating it. The former method will probably be preferable when it is grown for pasture. Because of the branching nature of its growth and of the strength of the stems when not crowded, the seeds should be sown thickly. And since they germinate slowly when encircled by the outer covering they should be sown in the fall rather than in the spring where the winters are not too severe. This plant should also be more easily harvested for fodder than cowpeas. It is not probable that beggar's ticks will render much service north of the Ohio river, but in many sections of the south it is certainly well worthy of most careful testing.

AUSTRALIAN SALTBUSH.

The Australian saltbush is of many species. The most useful of these that have yet been tried under American conditions is that known as *Atriplex semibaccata,* introduced into California in 1888. This plant is a child of semi-arid regions. It is possessed of peculiar power to grow in soils strongly impregnated with alkali. It furnishes both pasture and hay which are more or less relished by domestic animals. It has given encouraging returns in certain areas of California where the rainfall was less than five inches per annum. And, since it is easily established under suit-

able conditions, it should therefore prove of much value in providing forage and fodder in very considerable areas of the western and southwestern states.

The species of saltbush under discussion is spreading and drooping rather than erect in its habit of growth. The stems branch out very numerously from the crown, and branchlets covered with long narrow shaped leaves multiply on them in a marked degree. The outer stems, therefore, are fine and very numerous, but toward the base the larger stems become more or less woody (Fig. 24). The plants bear no little resemblance to the Russian thistle at various stages of their growth. The habit of root growth is much dependent on the character of the soil. In suitable soil the tendrils are numerous. They spread out not very far below the surface and throw down numerous rootlets into the subsoil below. On hardpan, however, they send a taproot far down, with but few rootlets on it.

Australian saltbush has already been tried with more or less of success in various counties of California, as described in Bulletin No. 125, issued by the experiment station of that state. The same is true of the more limited experiments conducted in Utah, Washington, Nebraska and various places in Texas and New Mexico.

Where semi-arid conditions prevail is unquestionably the place for this plant, and more especially on lands so impregnated with alkali as to practically forbid the successful growth of more valuable food products in the absence of irrigation. It may, therefore, have an important mission for many sections of the United States eastward from the Missis-

Fig. 24. Australian Salt Bush.
—Grown at the Minnesota University Experiment Farm.

sippi basin and up to that as yet undetermined northward limit which will hinder its successful growth. That its growth will be profitable where other and more palatable food crops can be grown is not at all probable.

The best modes of growing this plant have not yet been fully wrought out, but it is pretty certain that the practice of sowing the seed on well prepared land as soon as the first autumn rains come is a commendable one. It will be better probably to sow in rows, that the land may be kept free from intrusive weed growth for a time and from, say, six to eight or ten feet should be close enough for the rows, since in some instances plants reach out and cover a circumference of sixteen to eighteen feet, but that is very much more than the average diameter of the plant. At the Minnesota University experiment station, seed sown in May produced plants fully three feet in diameter by September 1st. The method sometimes practiced of starting the plants in pots and then transplanting them is too laborious for common practice over large areas. As they seed plentifully, the volunteer plants soon fill up the vacant space when at least a portion of the seed is allowed to shatter out. On alkali lands the seed will germinate better when simply pressed into the ground with a heavy roller than when covered, but on other soils it should be covered lightly.

Much conflict of opinion has been expressed as to the feeding value of Australian saltbush, but the difference relates more to palatability than to nutrition. There can be no question as to its valuable nutritive properties, since it stands high in protein. Some growers claim that stock will not eat it, but

a majority of these state that horses, cattle, sheep and goats are fond of it and thrive well on it. Where more palatable plants cannot be grown, the classes of domestic animals named will probably become fond of it, while those fed on more tasty products will eat it very shyly, as do sheep at the Minnesota University experiment station.

On the whole, the Australian saltbush is well worthy of wide and careful experimentation in all the semi-arid country in the United States. Information on the very best modes of sowing, pasturing, cutting and curing this plant, and of saving the seed, is not as yet forthcoming, at least under American conditions. Such knowledge will have to be gleaned from experiments not yet undertaken.

CHAPTER XII.

SUCCESSION IN FORAGE CROPS.

By succession in forage crops is meant that order in which they may be grown throughout the season so as to provide pasture in uninterrupted continuity, and so that each kind of forage may be grazed when at its best. The treatment of this question is difficult because of the great variation in the forage crops that are adapted to various sections in the wide area under consideration, and because of the no less variation in the climates of the same. No better plan, probably, can be adopted than to divide the country into sections, and to formulate a succession in forage crops that would be suitable to each. This division should, of course, have a due regard to similarity in conditions such as relate to climate and soil.

The various forage crops will be enumerated in the order in which they are usually ready for being grazed. They are not thus enumerated with the idea that the farmer shall grow all of them, or even a majority of them, in a single season. It would seldom be wise for him to do so. But they are mentioned in the order named that he may the more readily select such of them for being grown as shall best suit his purpose. Where grasses are a sure reliance, it will seldom be necessary for the farmer to grow more than one, two or three kinds the same year. Forage from grass should always be

looked upon as the great reliance for pasture, wherever such forage grows freely, whether spontaneously or otherwise. Other forage crops should be made auxiliary to it, unless the growth of grasses is so meager as to forbid giving these so prominent a place. Wherever practicable a reserve of grass forage should be held, as it were, for seasons of wet weather and for those periods of emergency when other forage crops may not be on hand or may not be ready for being grazed.

Grouping States and Provinces.—For the practical illustration of this question, the United States and Canada may be divided into eight sections. Beginning at the northeast, Section No. 1 will include all the arable country east of Lakes Superior and Michigan and north of the Ohio river. Section No. 2 includes the states west of Michigan and Ohio, north of the Missouri and Ohio rivers, taking in Manitoba, and east of the Dakotas and Assiniboia. Section No. 3 includes the states south of the Ohio and east of the Mississippi, and also the states of Louisiana, Arkansas and Missouri, west of the Mississippi. Section No. 4 includes the states west of Iowa, Missouri, Arkansas and Louisiana, south of Dakota and east of the Rocky mountains. Section No. 5 covers the states and provinces of Canada west of Minnesota and Manitoba, north of Nebraska and east of the Rocky mountains. Section No. 6 includes the Rocky mountain valleys north from Salt Lake. Section No. 7 includes the Rocky mountain valleys south of Salt Lake and extends westward to the sea. And Section No. 8 includes the narrow area north of California and between the Cascades and the sea.

And here it ought to be mentioned, that of necessity these divisions are more or less arbitrary. The factor of altitude alone may so affect plant growth as to materially neutralize the value of any attempts that may thus be made to illustrate succession in forage crops. Wind currents also have their influence, and likewise precipitation.

Succession in Section No. 1.—The rainfall in Section No. 1 is more abundant and timely than in any of the other sections, unless it be in No. 8. The soil is also well adapted to the growth of grasses, hence in this section every reasonable effort should be made by the farmers to utilize grasses as factors in forage. The influences that are so favorable to grass pastures are also favorable to the growth of variety in forage crops, hence the list of these that may be grown in succession is a long one. Prominent among these crops are winter rye, blue grass and other grasses, clover, mixed grains, as peas and oats, rape, vetches and cereals, corn and rape, sorghum, millet, clover, rape, winter rye and rape, cabbage and blue grass. These are mentioned in the order in which they are naturally in season for being pastured, but this order may be modified by the time at which they are sown or planted. For cattle, the more valuable of these are grasses and clovers, and next in point of value are mixed grains and sorghum. For sheep they are all possessed of much value, but after grass, none are more valuable than rye, sorghum and rape. With the aid of these three, sheep may be carried through any season in good form. For swine, clover and rape are the most valuable, and to these may be added peas and artichokes, not enumerated in the list given.

Succession in Section No. 2.—The succession in forage crops that may be grown in Section No. 2 includes winter rye, blue grass or native prairie, alfalfa, clover, mixed cereals, rape, corn, corn and rape, sorghum, millet, clover, cowpeas, soy beans, rape or turnips or the two mixed, cabbage and blue grass. In this section much of the soil is richer than that of Section No. 1, but the rainfall is not distributed so regularly, and the climate is warmer in summer, hence it is not quite so well adapted to the production of grasses. But it is better adapted, relatively, to the growth of such foods as corn and sorghum, or indeed to the growth of any of the pasture foods named which admit of being grown quickly. Less dependence should be placed upon grass forage than in Section No. 1, and more dependence, relatively, on such forage as is furnished by mixed grains, winter rye, rape, corn and sorghum. In the northern areas of the section, winter rye, clover and alfalfa cannot be grown with profit for forage, and in the southern part only can cowpeas and soy beans be grown with advantage. The forage crops other than grass that can be grown most successfully for cows and other cattle in all parts of this section are such as mixed grains, corn in summer fallows and millets. The more important of these crops that can be grown for sheep in all parts of the section are winter rye, sorghum, rape and turnips. The more valuable of the same for swine are mixed grains and rape. Of course in the southern half of the section, clover can be utilized with great advantage as swine pasture, and in the northern half the same is true of field peas.

Succession in Section No. 3.—The succession

in forage crops that may be grown in Section No. 3 includes besides certain grasses, winter rye, rape, crimson clover, alfalfa, the winter vetch and the sand vetch, mixed cereals, corn, sorghum of the saccharine and non-saccharine varieties, millet, cowpeas, soy beans, artichokes and peanuts. The more important of these forage crops include winter rye, rape, vetches, the sorghums and cowpeas. The three first mentioned will be specially valuable in cool weather, and the two last mentioned in the warm season. The mission of cowpeas in providing forage and soiling food in nearly all parts of the section may be made especially important. Mixed grains are considered of too great value to grow as forage in much of the area named. The more valuable of these forage crops for cattle are winter rye, the sorghums and cowpeas. The more valuable of the same for sheep are winter rye, rape, vetches, the sorghums and cowpeas. And for swine the more valuable are winter rye, rape, alfalfa, cowpeas, artichokes and peanuts. This section is favorable to the growth of certain of these crops in conjunction, as, for instance, winter rye and rape and cowpeas and sorghum.

Succession in Section No. 4.—In section No. 4 the succession in forage crops, in addition to certain native grasses, will include winter rye, the sand vetch and possibly other varieties of vetch, alfalfa, corn, saccharine and non-saccharine sorghums, cowpeas, soy beans and rape. The more valuable of these crops in furnishing forage for cattle will include winter rye, sorghum, cowpeas and the soy bean. These also, along with vetches and rape, would all provide good forage for sheep. For swine

the more valuable of these forage crops will include alfalfa and cowpeas. In some parts of the section, forage crops will be grown under irrigation. The rape plant will not be so valuable, relatively, as in some other parts of the country, because of the drouth and heat. Nevertheless, it should be given a place. But the sorghums and soy beans will be quite valuable, relatively, because of their drouth-resisting properties.

Succession in Section No. 5.—In Section No. 5 the succession in forage crops, in addition to the wild grasses of the prairie, will include winter rye, rape, mixed grains, peas, vetches, corn or corn and rape, sorghum, turnips and cabbage. Winter rye cannot be grown in all portions of this section, especially the north and northwest. Corn and rape can be grown with much advantage, particularly on the wide areas of fallow land that are usually found in the section every year. But in growing corn forage, a due regard must be had to choosing seed of the hardy varieties. Rape and turnips may be safely sown with nearly all grain crops. And pastures from mixed cereals will grow well when sown, in nearly all parts of the section. Sorghum may be utilized with no little advantage, but the climate is too cold, except in the extreme southern portion, for the non-saccharine sorghums. In much of the section peas can be grown in good form, more especially toward the north. The more valuable of the forage crops for cows include mixed cereals, corn and rye. To provide sheep pasture, all those named except peas may be grown with much advantage. And for swine, the more valuable will include rape, mixed cereals and peas. Rape may be turned to

excellent account in providing swine forage, especially when sown early.

Succession in Section No. 6.—In Section No. 6, in addition to certain native grasses, the succession in forage crops will include winter rye, alfalfa, clover, mixed cereals, peas, vetches, sorghum and rape. Alfalfa and clover may not succeed in the extreme northern portion of Section No. 6, but in the more southern valleys of the same they grow wonderfully well when supplied with water. Mixed cereals grow admirably under similar conditions, but where clovers will grow the same necessity does not exist for growing cereals for forage. The most important of these forage crops for cattle in this section is clover, next in order is winter rye, and after winter rye mixed cereals. These are all important for sheep and are easily grown for them, and, of course, rape and sorghum may be added to the list. Alfalfa, clover and peas are the most important for swine. With such pastures for swine, pork should be produced very cheaply and of unsurpassed quality in Section No. 6.

Succession in Section No. 7.—In many parts of section No. 7 the native grasses grow very shyly, because of the dry weather. More reliance, therefore, must be placed on the other crops that may be grown for forage. The succession in these includes winter rye, alfalfa, the saccharine and non-saccharine sorghums, the cowpea, soy beans, the sand vetch and rape. Much of the crop could only be grown by irrigation. Because of this, however, the succession in the crops could be more perfectly controlled than where irrigation is not practiced, and in the absence of a regular and reliable rainfall.

In the succession those pasture crops could be given the preference which grow again and again, as, for instance, alfalfa and the sorghums. For cattle the more important of these forage crops would be sorghum and the cowpea in summer, and alfalfa in winter. But the alfalfa thus pastured in winter should be grown chiefly in the late summer and early autumn. The more important of these crops for sheep would be winter rye, the sorghums, the sand vetch and rape. And for swine the most suitable pasture crops would be alfalfa, soy beans, cowpeas and rape.

Succession in Section No. 8.—In Section No. 8 the succession in forage crops is varied and comprehensive, more so, probably, than in any other part of the United States. It includes native grasses and nearly all the cultivated varieties that are grown in permanent pastures, clovers in all the important varieties, vetches in several varieties, as the winter, the common and the sand vetch, alfalfa, mixed grains, rape, cabbage and artichokes. The soils of this section are possessed of unsurpassed adaptation for growing clover in any of its varieties, and also for growing all, or nearly all, the grasses that are grown in western Europe. And the moist character of the happy climate would seem to keep these growing and therefore succulent during much of the year. It would be possible, therefore, to secure succession in forage from grasses alone. It is also probable that rape could be so managed that it would produce forage during much of the year, and the same is true of mixed grains. In growing these, great use could be made of peas or vetches, or of both, because of the marked adaptability of the

country for growing them. It would also be an ideal land for artichokes because of the long season for pasturing them off. In this section, therefore, the question is not so much which are the crops that may be grown in succession, as which are the crops which shall be chosen for being thus grown. Cattle could be kept very nicely nearly all the year on grass and clover pastures, and the same is true of sheep, and they could be finished on rape in the autumn or in the early spring. Swine could feed on clover, alfalfa and artichokes nearly all the year, and they could be finished on peas.

CHAPTER XIII.

SHEEP PASTURES GROWN AT THE MINNESOTA UNIVERSITY EXPERIMENT FARM.

During the past three years experiments have been conducted in growing various kinds of pasture for sheep at the Minnesota University experiment farm. This work was begun and carried out under the supervision of the author. It is unique in character and the results obtained have been not a little remarkable. Only the merest outline of the work can be given here, though every detail thereof should be of interest to the flockmaster.

Objects Sought.—The following are chief among the objects sought in the experiment, viz.: 1, to ascertain the extent to which sheep may be confined with safety to pastures other than those provided by the ordinary grasses without endangering their good health; 2, to ascertain the various plants that are the most suitable to provide such pastures, and also the relative suitability of these; 3, to ascertain the best modes of growing them and of pasturing them when grown; 4, to ascertain the maximum amount of sustenance that could thus be procured for sheep under the conditions, or, in other words, to find out how many sheep could be sustained on a limited area and also the mutton product therefrom for the season; and, 5, to ascertain the influence of such a system of pasturage upon the cleaning of the land and also upon the maintenance of fertility in the same.

It is evident that some of these problems, because of their complicated character, can never be carried to what may be termed an absolute demonstration. Approximate results only can be obtained and that is all that is claimed for the findings that are submitted below.

Outline of the Experiments.—The experiments were begun in the spring of 1895. During that year some fifty-three head of sheep and lambs were pastured for many days on the forage that grew on two and three-fourths acres of land. The pasture consisted of winter rye, rape, peas and oats, vetches and oats and sorghum. During the intervals in which these plants failed to provide a sufficiency of grazing, the sheep were given grass pasture.

In 1896, an average of eighty-six head of sheep and lambs were grazed during the whole season of pasturage on ten acres of land. Nearly two-thirds of these were mature sheep. The grazing began May 1st and it ended November 1st. The pasture was not supplemented by any grain except for a short period at the first, when the change was being made from dry winter food to succulent pasture. In addition to the pasture, 8.60 tons of cured fodder and 7.30 tons of soiling food were taken from the same ten acres. The cured fodder consisted of hay made from grass, peas and oats, and the first cutting of sorghum. The sorghum was injured by rain while it was being cured and was not much relished by the sheep. The chief of the crops grown were winter rye, fall and spring sown peas and oats, rape, corn and rape, sorghum, Kaffir corn, cabbage, rape and winter rye.

In 1897, an average of ninety-three head of

sheep and lambs were pastured on practically the same ten acres from April 26th to November 5th. No grain food was given after the change had been safely made from a winter to a summer diet, except to eight rams and ram lambs that were being reared for sale. In addition to the pastures, 10.33 tons of dry fodder were obtained from the land and also 10.39 tons of soiling food. The fodder was made up of grass hay, pea and oat hay, corn well advanced in growth and mature sorghum. It was all of excellent quality. The varieties sown were substantially the same as those sown the previous year, but there were some variations in the combinations sown and in the order of the succession.

The Sheep While on Pasture.—In 1896 and also in 1897, two and one-half acres of the ten acres were in grass pasture. In 1896, clover predominated in the pasture, and in 1897 timothy was in the ascendant. The sheep were grazed on this pasture when the other pastures were too wet because of rain or dew. The sheep barn, a view of which is represented in Fig. 25, stood in the portion laid down to grass. In the heat of the day the sheep were given the benefit of the cool shade furnished by the barn. At night they were also inclosed in the yards surrounding the barn to protect them from dogs. Corralling them thus at night would, of course, not be necessary under ordinary conditions, nor is it any advantage to their well-being.

SUCCESSION IN THE CROPS GROWN.

Winter rye was ready for being pastured several days in advance of blue grass and fully four to

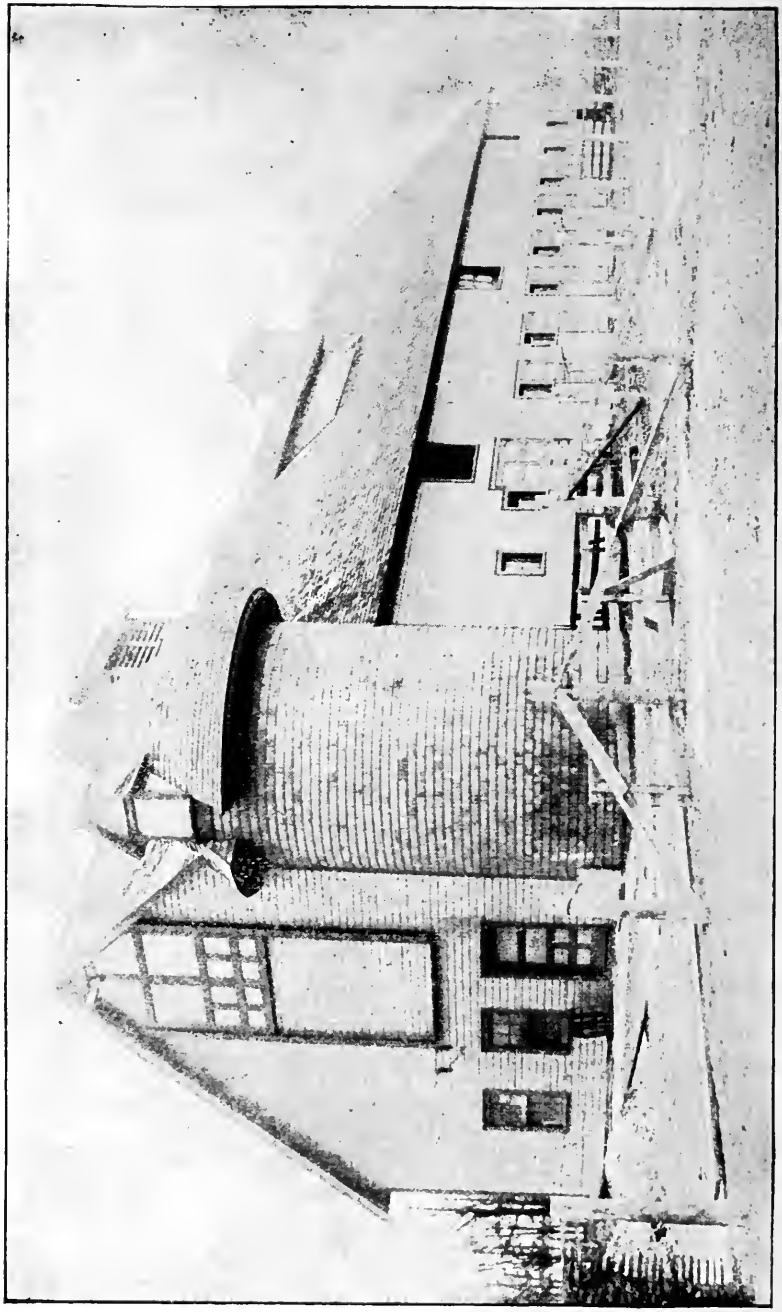

Fig. 25. Sheep Barn.—Minnesota University Experiment Farm.

five weeks of any of the spring sown cereals (Fig. 26 shows sheep pasturing on rye), and, with the exception of cabbage, it was the last crop that furnished good pasture in the autumn. It was also found that rye sown early enough in the autumn to become firmly rooted was ready to pasture much earlier and provided pasture more abundantly than rye put in so late that it had not become so rooted before the closing in of winter. Rye and grass pastures, therefore, carried the sheep from the opening of spring until some time early in June. The spring sown winter rye did not prove altogether satisfactory as a pasture. It grew luxuriantly for a time, but it ceased to grow when settled warm weather came. Later, it turned russet in color and finally died.

Peas and oats were the next crop ready. They were sown as soon as the work could be done after the dawn of spring. The pasture which they furnished was greatly relished by the sheep. In one instance the pasture was grazed down three times in succession with an interval of two weeks or more between the periods of grazing. Rape was then sown on the same ground. In another instance they were grazed off three times in succession, as just stated, after which the clover and timothy sown at the same time as the grain were given time to gather strength to fortify the plants against the rigors of winter, and in other instances the peas and oats were grazed down once, after which the second growth was mown for hay. Figure 27 represents a rape and clover pasture. The "catch" of the grass seeds thus obtained was all that could be desired. But the tests thus made have covered only two seasons. In

Fig. 26. **Sheep Pasturing on Winter Rye.**
——Minnesota University Experiment Farm.

1897, the clover blossomed and produced much seed, but the crop was left to enter the winter undisturbed.

Rape was the next pasture ready. It, too, was sown as soon as the ground was suitable, and it was sufficiently grown for being grazed just after the first grazing of the peas and oats. In one instance it was eaten down four times during the season. Figure 28 represents the grazing of this crop the second time it was eaten down. In another instance it was grazed off twice and then the clover sown along with the rape was allowed to grow undisturbed. In yet other instances it was allowed to approach the maximum of full growth, and after being grazed down was followed by such crops as sorghum, or cabbage. More food was obtained from the last named method, but it also involved more labor. Rape was also sown at various times as the season progressed, so that a reserve of rape pasture was usually on hand when wanted, from the middle of June until the end of October. In point of palatability rape should probably be given the first place among the forage plants that were grown.

The first grazing of the rape was no sooner completed than *corn*, or corn and rape sown together, was ready. Corn that had reached a foot in hight never grew again when eaten down. In some instances, therefore, this crop when consumed was at once followed by another crop, as rape, sorghum, or rape and winter rye. But in one instance the rape was allowed to produce a second growth, with results that were on the whole encouraging. More pasture was obtained, however, from the two crops grown in succession than from the two successive grazings of the one crop, but more labor was

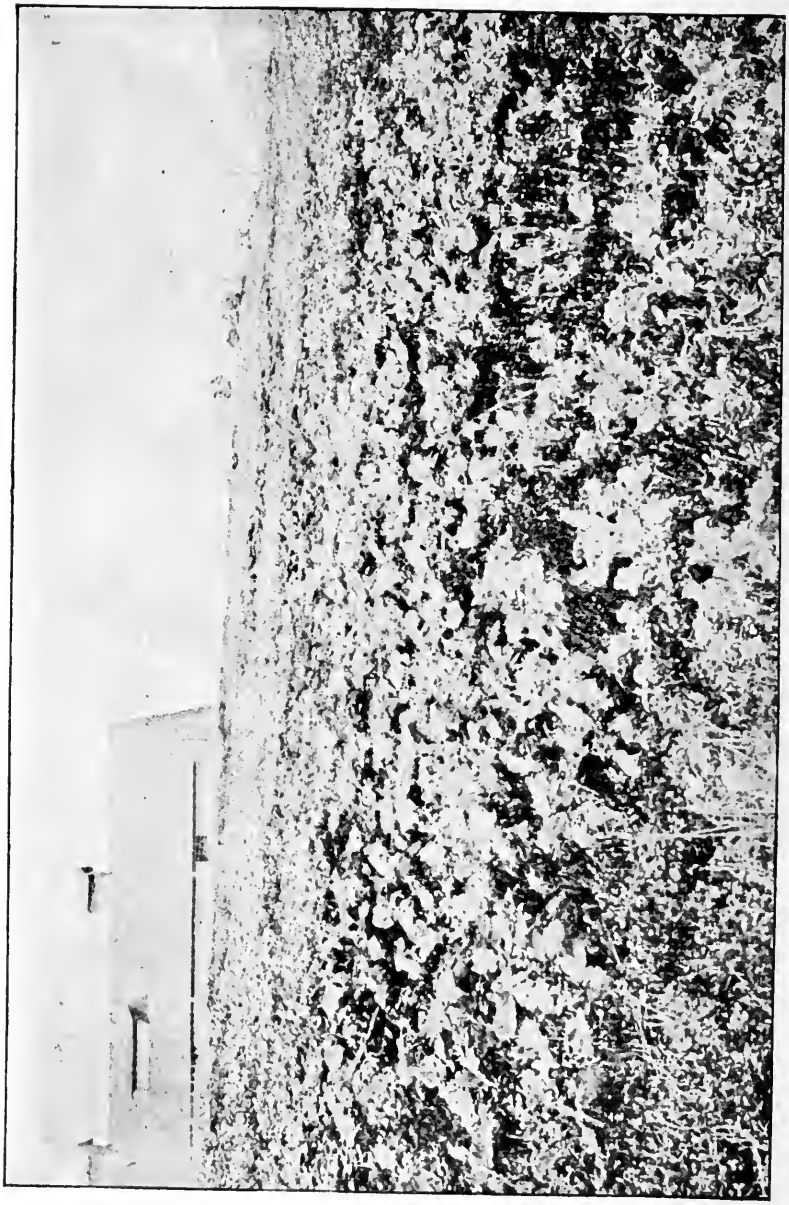

Fig. 27. Rape and Clover Pasture
—Minnesota University Experiment Farm.

also involved. The corn crop was ready for being grazed in about six to nine weeks from the date of sowing.

As soon as the corn was grazed down, *sorghum* was ready. It was sown alone in nearly all instances, but on two or three occasions rape seed was mixed with the sorghum seed. The advantage of thus growing the two plants together was not clearly apparent, as either the rape or the sorghum was pretty certain to crowd the other, but the plan should not be condemned without further trial. Figure 29 shows sorghum and rape, the third pasture crop grown on the land for the season. The first was rape and the second was corn and rape. In one instance the sorghum was mown and then pastured. In some instances it was grazed down three times in succession and in others but twice. Whenever it was deemed expedient, the sorghum was followed by winter rye sown to provide pasture for the following year, as the sorghum ceased to furnish any more pasture after the first frost. Sorghum is not relished so highly as some of the other pasture plants grown, but when the animals are confined to it they consume it with an evident relish, and they make much better progress than if confined to dry and inadequate grass pastures.

The last crop grown in the succession was *cabbage*. The seed was sown in rows thirty inches distant and at various times. On one plot it was sown as early as May 11th and on another as late as July 8th. The late heading varieties sown early proved the most satisfactory, but this may not hold true of localities in which the cabbage worm *(Pieris rapae)* is not troublesome. This crop proved more satis-

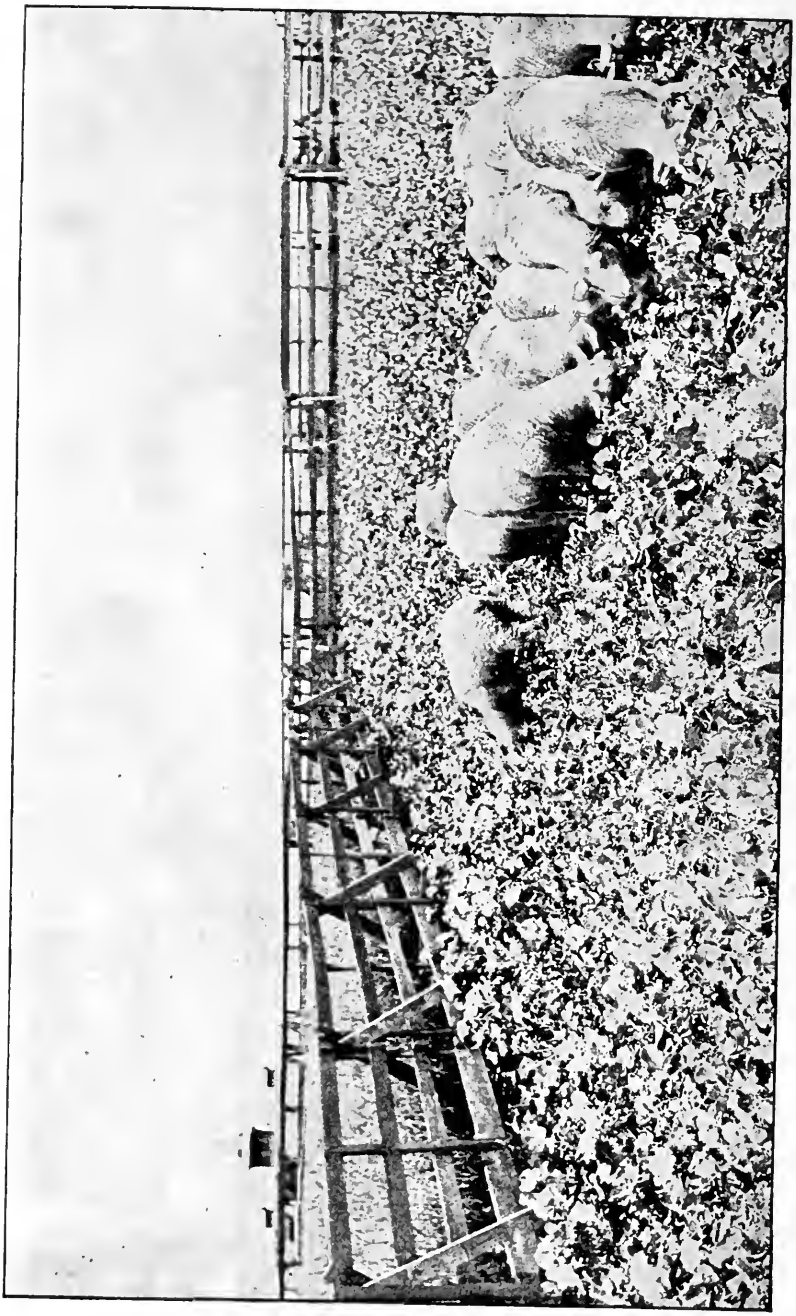

Fig. 28. Sheep Pasturing on Second Growth Rape.
—Minnesota University Experiment Farm.

factory, all things considered, than any other in providing pasture in the autumn after the arrival of heavy frosts. Severe frosts injure cabbage less than rape. If given time enough, sheep will eat the cabbage down close to the stem and with almost no waste.

When to Begin Pasturing.—The stage of advancement in the various crops at which the pasturing ought to commence will depend upon various conditions, as, for instance, the area to be pastured, the habit of growth in the crop and the character of the season. The larger the area to be eaten down, the greater the tendency in the plants to sprout up again, and the more moist the season, the sooner may the stock be turned into the pasture to graze upon it.

The pasturing of *winter rye* in the spring should begin ordinarily as soon as the rye has begun to grow vigorously, and the aim in pasturing should be to keep it short. It is then more relished and it also furnishes more pasture. In no instance should it be allowed to reach the stage of shooting up to form the ear before it is grazed down.

Peas and *oats* should not be allowed to get more than six to ten inches high before the pasturing is commenced, and when the area sown is large, it may be advantageous to turn in the stock before the crop reaches the hight of six inches.

The pasturing of rape may begin when the plants are, say, twelve inches above the ground, but it would seem to be true that more pasture will be obtained if the rape is allowed to attain its full growth before it is eaten down, and the pasture thus obtained is probably more valuable. If more than

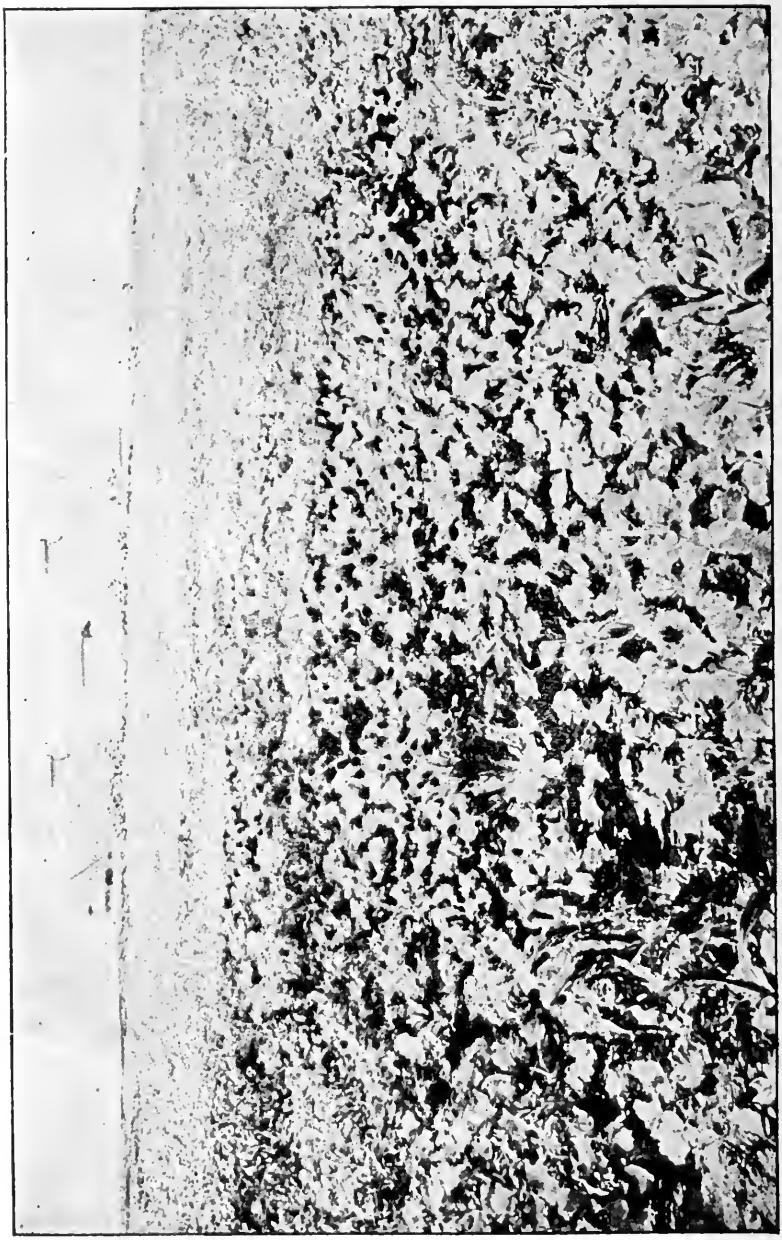

Fig. 29. Sorghum and Rape Pasture.
—Minnesota University Experiment Farm.

one growth is to be taken from the plants they should not be grazed off closely.

Corn, since it does not sprout again, except when grazed while quite young, should be allowed to reach the hight of several inches before the sheep are given access to it. If they should break much of it down while pasturing upon it, they will consume not a little of what has been so broken in the cured form.

The pasturing of *sorghum* should begin at an earlier stage, relatively, than the pasturing of corn, in fact, any time after the plants have become so firmly rooted that they cannot be pulled up by the sheep while being grazed. But it may be deferred to a later period if circumstances should call for such a course.

Cabbage should be allowed to attain a maximum of growth before the grazing is commenced. If matured before the desired season of pasturing, a portion of the leaves on each plant will wither and waste away, which means a loss of food in proportion to the extent of the wasting of the leaves.

When grazing down such of these pasture crops as grow up again and again, more pasture will be obtained when the grazing is done quickly and in successive periods, with an interval between these, than when animals are allowed to remain continuously on the pastures. In other words, alternation in pasturing such crops is better than continuous pasturing.

Comparative Yields.—The amount of pasture furnished by the respective crops, as was to be expected, varied from time to time and from year to year. The following, however, were the maximum

yields obtained from the various plants named below in a single season. They represent the pasture obtained from one-fourth of an acre. Rape alone furnished pasture sufficient for one matured sheep for 356 days; corn followed by sorghum for 507 days; rye followed by sorghum for 590 days, and cabbage alone for 762 days. One acre of cabbage of similar development would have furnished food enough to sustain one sheep for eight years and 128 days.

But these yields must not, by any means, be regarded as the largest that may be obtained from any of these crops. The soil on which they grew was comparatively infertile. Under the most favorable conditions it would be possible to obtain from rape, for instance, not less than three times the amount of pasture mentioned above. And it should also be borne in mind that the crops which furnish the largest yields of pasture are not necessarily the most productive in mutton and wool. The food constituents in some are much richer than in others.

Mode of Hurdling.—While pasturing off the various plats, movable hurdles were used. The following is a description of these hurdles: Each panel is composed of four boards. The one at the bottom is 6x1 inches and the others are 4x1 inches. Across these are nailed three slats or crossbars 4x1 inches. Two of these are nailed six inches from the ends of the panel and on the same side of it, one being at each end. The third is nailed across the center and on the other side of the panel. The bottom space thus formed is six inches, the middle space six and one-fourth inches and the top space seven

and three-fourths inches. The second board from the top is cut off flush with the outer edges of each end crossbar.

The headpiece consists of three boards nailed together so as to form a triangle. The bottom board, 6x1 inches, is three feet six inches long on the ground side. The two upright pieces are 4x1 inches and four feet long. One is nailed on each side of the sole piece and they cross each other at about six inches from the upper ends. Two notches are cut, one above and one below. These are two inches wide and three inches deep. They receive and hold the top and bottom boards of the panels when in place. Wrought or wire nails are used.

When these hurdles are in place, the headpiece stands at right angles to the panel. But strong winds will sometimes tip over such a fence. To prevent this, short stakes made of strips of inch boards may be driven down at intervals alongside the headpiece and fastened to it with a nail, which should not be clinched, so that the stake may be easily loosened when the fence is lifted. Such a fence is not costly. It can be quickly and easily moved. It can be stored away with but little labor when not in use, and if handled with due care it would last for many years. But there would be more wear to it if the boards in the headpiece were made of thicker lumber, as they would not then split so readily at the notches. It is possible, however, that other styles of hurdles may yet be introduced that will better serve the end sought.

Character of the Soil.—The soil is what may be termed rolling in character. In composition it is a sandy loam on the surface. In texture it is so

open that much trouble was caused by the washing of the soil through heavy rains. In depth, the surface soil varies from, say, six inches on the high ground to eighteen inches on the low ground. Underneath the subsoil is chiefly gravel and sand admixed. The crops, therefore, as can easily be imagined, soon showed signs of languishing on the higher ground when the weather became dry and hot.

Nor was this quick-growing, though naturally hungry soil in a high state of fertility. From the beginning of 1891 to 1895, no manure had been applied, notwithstanding that a grain crop had been taken from the land every year. In 1897 a moderate dressing of barnyard manure was applied. No additional fertilizer was used during all these years, save on inconsiderable portions to aid in growing certain special crops.

Character of the Weather.—During the three seasons of the experiment, the weather was, on the whole, favorable to the growth of these pasture crops. Showers fell with a fair amount of regularity. In some instances the moisture from the same was superabundant, while at other times there were intervals of several weeks between the showers. With less favorable weather the results could not have proved so satisfactory. But in justice to the system it ought to be stated here, that in dry seasons the results from growing sheep pastures as in this experiment would be relatively even more favorable when compared with results from grazing grass pastures only, than they would be in a wet season.

Necessity for Some Grass Pasture.—When growing these crops for pasture, it will be necessary

to have a reserve grass pasture on which to graze the sheep as occasion may require. For instance, if sheep are grazed upon these crops when wet with rain or even heavy dews, the treading of the land at such times will tend to impact it and to break down and befoul the food. It will also tend to saturate the fleece with water, more especially when the food is rank and tall. To avoid these hazards, a grass pasture should be on hand where the sheep may graze after rain and where they may graze and rest at night. Such a pasture is always opportune, as when an interval may occur during which the other pastures may not be ready for being grazed, and the variety thus furnished is also helpful.

Health of the Animals.—The health of the animals was exceptionally good. Five animals only were lost during the three seasons of pasturing. Of these, four died from hoven or bloat while feeding on the clover in the grass pasture in the spring of 1896. The fifth animal died of what was diagnosed as pneumonia. There was no instance of bloat while feeding upon the other foods.

Effects on Weed Growth.—Growing crops as in the succession given above proved quite destructive to weed growth. But few weeds were given time to mature because of the frequent stirring of the land and also because of the cropping down by the sheep. It is doubtful if any method could be devised that would be so potent in quickly subduing weeds in the soil and at so little cost. Early in the season, while the weeds were juicy and tender, they were usually the first food eaten by the sheep. But later, some varieties, particularly summer grass

(Setaria glauca) were not consumed so eagerly. But the seed pods and seed heads of the weeds were consumed wherever these had been produced. The weeds were turned into mutton.

Influence on Fertility.—The influence on the fertility of the soil was marked. Since but little of the food was removed from the pastures, the product of the same went back on the land and in a readily available form. When sheep are thus grazed upon land, if in addition to the pasture they are also fed some grain or oil cake, the soil must soon become rich in fertility and virtually without labor, for the return in mutton and wool should in itself bring a direct net profit.

Sixteen Sheep Pastured on One Acre.—A second experiment was carried on, which also formed a part of the first experiment. It was an experiment within an experiment. It consisted of pasturing sixteen animals on one acre as far as it was found practicable throughout the growing season. Of these, six were dams and ten were lambs. The acre was divided into quarters, and the pasturing alternated on these. During two successive years was this experiment continued, beginning with 1895. It was not found practicable to keep the sheep confined to the acre through all the season. There were some short intervals each year during which they had to be kept on other pasture, and in some instances had other sheep to be brought in to eat down the excess of pasture. After balancing the pasture borrowed against the pasture given away, it was found that the acre thus pastured in 1895 and also in 1896 had sustained the sixteen animals for about five months. With soils rich and productive,

the results could doubtless be considerably exceeded. No grain was fed during the experiment, save for a few days at the first, when the change was being made from winter to summer food. The ten lambs made an increase in live weight of 560½ pounds while pasturing on the acre in 1895, and of 532 pounds while pasturing on the same in 1896.

Conclusions.—The following are prominent among the conclusions that may be drawn from the experiment:

1. That sheep may be carried safely through the summer when confined chiefly to pastures other than the common grasses. The uniformly good health of the sheep during the three years of the experiment was one of the most encouraging of its features. When sheep can be confined to such pastures in the early summer, the danger from parasitic troubles will be materially decreased, and more especially with the lambs.

2. That in the United States and Canada a great variety of plants may be grown to provide such pastures. Those which are the most suitable for each locality will vary with the conditions.

3. That among the plants adapted to such a use, winter rye, sorghum and rape are worthy of a prominent place. Each in its season produces a large amount of pasture. Each can be grown in nearly all parts of the United States and Canada possessed of an arable soil, and each is the complement of the other two. Winter rye furnishes pasture in the spring and in the autumn, but chiefly in the spring. Sorghum is at its best in the hot weather of summer, and rape is emphatically the autumn pasture plant. With these three and a

grass pasture, sheep can be kept on succulent food all the season.

4. That with the aid of such pastures a much larger number of sheep can be kept upon an arable farm than could be sustained by grass pastures without the aid of these. The extent of such increase will depend upon a number of conditions.

5. That such a system of pasturage is eminently helpful in destroying weeds and also eminently beneficial to the land, as explained above.

The Principle in the Experiment.—It may be mentioned here, and with much propriety, that this experiment is not intended to be an absolute guide for the farmer. The chief aim sought in carrying it on was to demonstrate the possibility and the practicability of pasturing sheep during the greater portion of the season on pastures other than grass, that is to say, on pastures sown expressly for the purpose. The principle thus sought has been demonstrated, notwithstanding that many things about it are yet undetermined, as, for instance, the relative suitability of certain foods for the purpose, and the very best methods of growing them, also the relative profit in pasturing sheep thus as compared with pasturing them on grass only. Some of these, of course, can never be determined other than in an approximate way.

The Application of the Principle.—The application of the principle must be made by the flockmaster himself, and in consonance with the nature of his surroundings. For instance, he must ascertain, first, which of these summer crops are the best adapted to his conditions; second, how many of them he will grow and the relative acreage of each; third,

the succession at which he shall grow them, and, fourth, the nature and extent of the fencing required. Though the principle is applicable in all the arable sections of the United States and Canada, the application of it will vary with the surroundings, and it will vary from year to year with the specific requirements for that particular season.

There are but few flockmasters, however, possessed of tillable land who cannot embody the principle, to some extent at least, in their practice. They can grow one or more of these foods to pasture the sheep on when the grasses are dry. That alternation in grazing off the pastures may be possible, the fields may either be permanently fenced, or movable fences may be used. The greatest convenience and profit will most probably be found in combining the two ideas, that is to say, in having some fields long rather than broad enclosed with permanent fences, and then using some portable fence to be placed across the narrow fields as occasion may require. With winter rye, sorghum, rape and a grass pasture, sheep can be supplied with succulent food from spring until the advent of winter. In some seasons one of these along with grass may suffice, in other seasons two of them, and yet, again, all three may be necessary. But various other plants may yet be introduced which will possess even superior adaptation in providing summer pasture for sheep.

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